NEWSLETTER 1 + 2 / 1995

E.S.S.C.

EUROPEAN SOCIETY FOR SOIL CONSERVATION

Snowmelt Erosion on a potato field

E.S.S.C. NEWSLETTER 1 + 2 / 1995

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EDITORIAL

Our first newsletter of the year appears too late to make New Year Greetings appropriate but, to make up for the delay, our Editor-in-Chief has produced a bumper issue. We have nearly thirty pages devoted to reports on soil management in Norway which were first presented to a rather limited number of Executive Committee members at their meeting in Ås last October. I would like to record a special thanks to all the Norwegian scientists who gave of their time to host us and prepare a very interesting programme. I am pleased that, through the Newsletter, the efforts can be shared by all of us.

The Society continues to go through a period of consolidation rather than growth but hopefully this period will pass soon and we shall start to expand again. We are beginning to experience the difficulties of bringing the Society together for two meetings a year, given the competition for time with other conferences, and the costs of European travel. However, we must not let our efforts drop because care and conservation of the soil underpins the success or otherwise of all human activity requiring use of the land. We need more offers to organize interesting meetings, workshops, seminars for the coming years, particularly in areas which lie within the remit of the Society but which we have not yet explored. In this way we shall recruit new members. Membership is still our only source of funding and is therefore our "life-blood". If you still have unpaid subscriptions, it is vital that you pay them straight away.

I look forward to seeing you all in Tenerife in July and later in Moscow in September. Please keep the contributions coming in to the Newsletter. We have had a number of interesting reports from Council members and these will be included in later issues. Above all, we need your ideas on how to develop and improve the Society. Please give your suggestions to any Council or Executive Committee Member.

With best wishes for a successful year.

R P C Morgan

President

A PRESENTATION OF JORDFORSK, CENTRE FOR SOIL AND ENVIRONMENTAL RESEARCH

JORDFORSK was established as a private, not for profit foundation in 1980. It was a merger between The Norwegian Soil and Peat Society (established 1902) and The Norwegian Agricultural Research Council's Institute for Georesources and Pollution Research (established 1983).

JORDFORSK's main objective is to conduct applied research for long-term management of soil, water, landscape and waste, based on sustainable production.

JORDFORSK's staff consists of 75 employees, of which 45 have university degrees, and 20 have diplomas in engineering or a technical education. The remaining 10 employees work in administration.

JORDFORSK is governed by a Board of Trustees, and a Committee of Representatives. The foundation has about 900 members. The chairman of the Board is Ingvald Ulveseth. In the Board there is one member from The Ministry of Agriculture and one from The Ministry of Environment. The Committee of Representatives elects three board members, and JORDFORK's staff is represented by two members.

JORDFORSK is organised in two departments, a service laboratory, and the administration. Department for Environmental Monitoring and Environmental Measures (Head Nils Vagstad) works with soil resources and environmental information, ecological engineering, water and nutrient balances in the cultural landscape. Department for Soil, Water and Waste Resources (Head: Oistein Vethe) works with hydrogology, toxic wastes in soils, soil biology and waste management. The erosion research is carried out by the group working with water and nutrient balances in the cultural landscape. A national soil monitoring programme, and a national programme for ecologically based wastewater treatment are coordinated by JORDFORSK.

The Norwegian Agricultural Service Laboratory is the largest in Norway for chemical soil analysis. Head: Alf Reidar Selmer-Olsen. The laboratory also carries out analyses of water, wastes, peat and other growth media, nutrient solutions, fertilizers, etc.

JORDFORSK owns two research farms and about 5500 hectares of land all over Norway.

JORDFORSK increased its income from 28 million NOK in 1990 to 38 million NOK in 1993. Core funding by the two Ministries accounts for approximately 30 percent of the annual income.

JORDFORSKs main office and laboratory are situated on the campus of the Agricultural University of Norway, at Ås, 30 km south of Oslo.

In the following articles a description is given of the work concerning water erosion and connected investigations.

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A BRIEF OVERVIEW OF NORWEGIAN AGRICULTURE AND ENVIRONMENT

Background

Norway is a rural country, covering about 324000 sq.km. The population is relatively small, 4,2 millions. Arable land covers only 3 % (1 million hectare), most of which is in the southern part of the country.

After world war II, Norway developed a rather complex and comprehensive system of regulations and subsidies within the agricultural sector. One important goal of this policy was to ensure a sufficient economical base for human activities in remote districts.

The physical geography of Norway is characterized by huge variations in soils, climate and topography. For instance, annual precipitation ranges from less than 400 mm to more than 3000 mm. Most of our agricultural land, however, is located in regions with low to moderate/high level of precipitation (500 to 2000 mm).

Agricultural statistics

The agriculture society is distinctive divided between animal husbandry and cereal production. Most of the land with cereals is located in the south-east part of Norway. Soils are mainly marine deposits, with clay content up to 40 %. Average annual precipitation is generally between 500 and 1100 mm, however, quite often with a pre-summer drought causing water deficiency in the tillering phase of the cereals, particularly on soils with low available water capacity, or soils with poor soil structure.

Animal farming is mainly located in other regions, especially the western and south-western regions. The south-western region is characterized by rather high intensity, with livestock density between 2 and 3 animal units per hectare as quite common. The regions of animal farming corresponds to those with high rainfall.

Approximately 35 % of the agricultural land is used for cereal production. The rest is mainly used for grass production (silage) and grazing (55 %). Average N-application (by fertiliser) for cereals is approximately 105 kg/ha, and for meadow approximately 135 kg/ha.

Generally speaking, Norwegian agriculture is of moderate intensity. Consumption of nitrogen fertiliser has been fairly constant over the last 15 years, approximately 110 kg/ha. Phosphorus, however, decreased by more than 50 % since 1984, to a present level of about 15 kg/ha. The livestock density, on a national level, is below 1 animal unit per hectare (1 animal unit corresponds to 1 milk cow).

Environmental issues

Soil erosion in cereal production and nutrient losses from animal farming have been considered to be the most important environmental problems in Norwegian agriculture, although attention over the last years have been directed more towards "the nitrogen problem".

From 1950 to 1992, the ratio between the areas of cereals and meadow in the Oslo-region (south east part of Norway) changed from 0,75:1 to 10:1. The number of animals decreased continuously, followed by a significant increase especially in the south-western part of the country. Fields were intensively drained (with financial support from the authorities), and channels and small streams were tiled. The marine deposits in the Oslofjord region are in many cases cut through by ravines or gulliar, and thus less suitable for the modern and mechanized agriculture. To meet the "technical requirements" of the change in cropping systems, levelling of the gullied landscapes was initiated. In Akershus county approximately 20 % of the agricultural land is levelled. It might correspond to the removal of 5 to 10 meters of soil on the crest of the ravine - to be deposited in the depression. This change makes strong demands on the hydrotechnical management, to avoid severe problems with erosion and soil stability.

Briefly, the environmental impacts have been;

* Increased losses of Nitrogen due to the change in cropping systems
* Increased soil erosion and Phosphorus losses
* Increased soil erosion due to levelling of agricultural land
* Increased losses (runoff) from animal manure due to increased stocking rates in humid regions
* Loss of natural capacity of self purification due to intensive melioration

Soil erosion, especially on the levelled land, might be severe. Erosion caused by heavy rainstorms during the growing season is not a serious problem. The late autumn and particularly the spring season are more important. Normally, the soils are frozen during the winter. However, several times during the last 10 years, unstable winter conditions with rapid shifting between freezing and thawing have created huge erosion incidents. Gullies or large rills are rather common on sloping fields with typical topographical depressions and concentrated surface water flow.

To cope with the erosion problem, the government has initiated an action plan to change tillage operation methods on grain fields or erodible land and to improve surface water management by different hydrotechnical solutions. Today, reduced tillage and spring ploughing are practised on approximately 40 % of the cereal land. A subsidy is paid to farmers who practice soil conservation tillage on erodible land.

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Environment control, monitoring and research

To provide data on environmental impacts of agricultural activities, four different approaches are used: (1) natural resource surveys, (2) statistical surveys and questionnaries, (3) remote sensing and (4) on-site monitoring and research.

Comprehensive statistics are provided annually concerning management practices within agriculture, e.g. timing and methods of tillage operations, manure management, fertiliser application, use of pesticides. This information is based on a sampling survey/questionnary among approximately 20'% of all "active" farmers.

Remote sensing (satellite images and air photos) are used to determine how well land use and tillage methods are adapted to the natural erosion risk.

Soil erosion and nutrient runoff from agricultural fields have been under comprehensive research and monitoring for a number of years. Different soils and agroecological zones are covered, and measurements are conducted on many different scales; microplots and lysimeters, field lysimeters (USLE-plots), fields/small catchments (1 to 20 ha) and full scale catchments (up to 700 ha).

Effects on soil erosion and nutrient runoff by different tillage methods are studied in USLE-plots. Time series for more than ten years are available. Special studies are carried out to cope with the fact that nutrient runoff, and especially soil erosion, is typically event based.

Full scale catchment monitoring was initiated in 1985. Much attention and work has been spent on scientific approaches and methods, concerning both the hydrological measurements, water sampling procedures and equipment. Keeping in mind the dynamics of the soil and nutrient transport from the outlet of an agricultural catchment, methods used for measurements should be chosen with utmost care. If not, the reliability of the data provided could be low. Nearly all our measuring stations today, from field lysimeter level to full catchments scale, are provided with equipment for volume proportional water sampling. Water samples are collected automatically, and discharge data are for some stations transferred directly from the on-site datalogger to the research computer in the office.

Summary conclusions

Generally speaking, the environmental status of the Norwegian agriculture has improved significantly over the last 10 years.

The most severe problem in our agriculture is probably the soil erosion connected to cereal production.

The status of environmental information related to agriculture is rather good. Our measurements concerning nutrient runoff and soil erosion are many, and generally of high quality.

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DESIGN AND INSTRUMENTATION FOR RUNOFF MEASUREMENTS AND SAMPLING ROUTINES IN AGRICULTURAL CATCHMENTS

Summary

The design and instrumentation of JORDFORSK stations gives at all scales highly accurate, representative data regarding runoff measurement and sampling of transported suspended and solute loads. The scaled approach to measurement aids understanding of the different processes occurring, and model calibration.

1.0 Introduction

JORDFORSK is, in cooperation with the Norwegian Agricultural University and the State Agricultural Research Institutes, carrying out an agricultural monitoring programme. This programme is part of Norway's commitment to reducing the export of nutrient pollution to the North Sea, in accordance with the North Sea Declaration.

This report is in the form of an extended abstract and will describe the scaled measurements within Mørdre-catchment, the sampling strategy employed and the reasoning behind their usage.

2.0 Catchment Description

The Mørdre catchment, situated in southern Norway (50 km NNE of Oslo) provides an example of measurement strategy layout. It covers approx. 680 ha and lies approx. 200 m above sea level. The catchment is dominated by agricultural landuse(70%). The topography is varied, with undulating plains (some artificially levelled) and, in areas, steeper slopes towards the main watercourse. The catchments soils comprise predominantly clay and silt fractions.

2.1 Field Layout

The measurements at Mørdre-catchment are carried out at four different scales. Table 1 shows the hierarchy adopted.

Scale	Area	Measurement structure/data recording	Type of measurement
1	680 ha	Crump weir/data-logger	Total runoff, water sampling
2	10 ha	RBC-flume/data-logger	Surface/sub-surface runoff, water sampling
3	125 m^2	Tipping bucket/data-logger	Surface runoff, water sampling.
4	25 m^2	manual recording/sampling	Water and nutrient transport in plant/root zone

Table 1. The measurement level hierarchy used at Mørdre catchment

Runoff, erosion and nutrient loss are measured at all three scales. At scale 4, measurements are taken from the unsaturated (vadose) zone. This scaling of measurement provides opportunities to cross-reference findings and aids the study of model calibration. Figure 1 shows, diagramatically, how this hierarchy is set out.

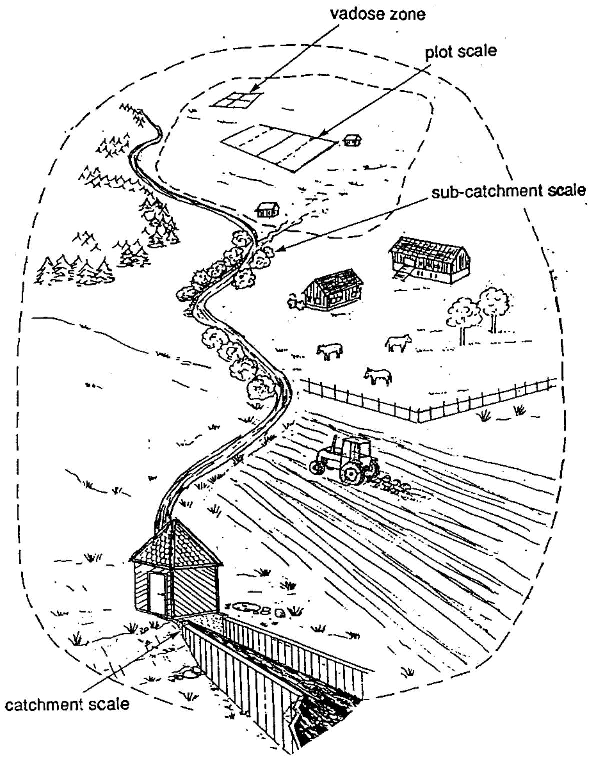

Figure 1. Catchment Site Layout

3.0 Measurement Principles and Equipment

3.1 Measurement principles

To obtain accurate, reliable data about the erosion and loss of nutrients from an agricultural area, one needs accurate runoff and chemical data. Knowing that substance concentrations in runoff (both suspended and solute) vary with discharge, the hydrological and chemical data can thus be used together to give more realistic estimates.

All measurement stations operated by JORDFORSK are provided with a data measurement and control module (data-logger). Water levels are measured continuously and discharges are calculated on the basis of the known head-discharge relation for the monitoring station. A small sample is taken (v), each time a preset volume of water has passed the monitoring station. Sampling is triggered by the data logger and the sub-samples are collected into a container for subsequent analysis. The sample container will contain a composite sample with a total volume (V_{tot}), representing the average water concentration (C_{comp}) over a sampling period.

$$C_{Comp} = \frac{c_1 \times v + c_2 \times v + ...c_n \times v}{V_{tot}}$$

The substance transported (S) is calculated on the basis of the continuously recorded discharge (q) and the composite chemical concentration (C_{comp}).

$$S = C_{comp} \times \int_{t}^{t_n} Q \times dt$$

This method of sampling is considered to give the most representative estimate for runoff and transported substances. Comparative studies, between different point sample and the discharge volumetric composite sample strategy, have been carried out by JORDFORSK. Large errors in calculated substance transported, based on point samples, are reported (Eggestad, H.O, et. al., 1994).

3.2 Measurement Equipment

3.2.1. Catchment Scale

V-notch weirs were predominantly used as discharge measurement structures. Especially in areas with erosion, problems have arisen with this type of structure. Therefore JORDFORSK opted for a Crump weir as discharge measurement structure at catchment scale. This type of structure performs well at transporting sediments, thus cutting down on maintenance requirements and improving long-term accuracy of measurement. The catchment scale measurement station set-up is shown in Figure 2.

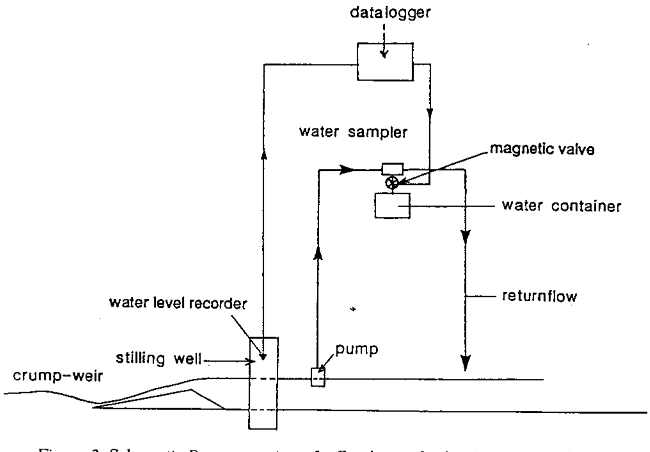

Figure 2. Schematic Representation of a Catchment Scale Measurement Station

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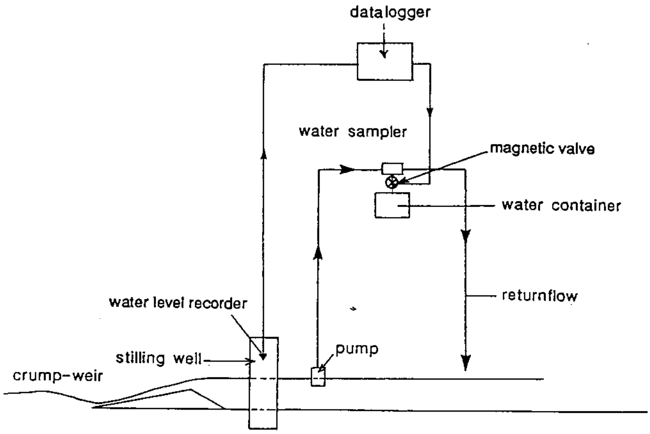

Figure 2. Schematic Representation of a Catchment Scale Measurement Station

Water head is measured using pressure tranducers or an ultra-sonic water head recorder. Water head is recorded by means of a data logger and sampling triggered automatically each time a known volume of discharge water has passed the station. Water for sampling is continuously pumped up and a small sample with fixed volume is extracted by means of a simple magnetic valve. Sampled water is collected in the water container, placed in a refrigerator.

The measuring system is connected to the telecommunication network. Each day, the data, stored in the data-logger, are retrieved automatically, controlled and stored in a database.

3.2.2. Sub-Catchment Scale

Measurement systems utilizing a V-notch weir have generally been used at this scale. Similar problems have occurred to those at the catchment scale. Therefore, another discharge measurement structure was selected, the RBC flume(Bos, M.G., et al, 1984). This structure is relatively easy to construct and install, has a wide measurement range and transports sediments well, giving long term accuracy at a low maintenance requirement. Water head is measured using a float, specially developed by JORDFORSK(Deelstra, J. et al, 1994), sited in a stilling well, and recorded by means of a data logger. Sampling is triggered under the same conditions as at the catchment scale of measurement. The main difference concerns water sampling. There is no access to the main power supply water and therefore water cannot be pumped up continuously. Instead, each time sampling is triggered, a small 12 V- pump is activated. The accuracy of the pump to deliver a constant volume over time is high when certain specifications are fulfilled (Deelstra, J. et al, 1994).

The layout of an sample sub-catchment station is shown in Figure 3.

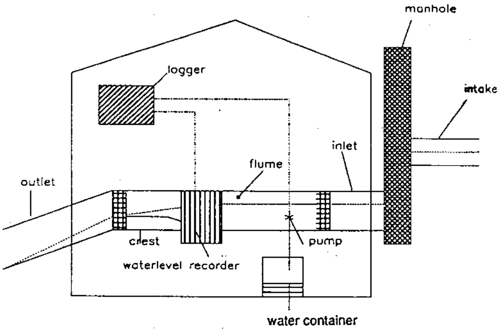

Figure 3. Schematic Representation of a Sub-Catchment Measurement Station

3.2.3. Plot Scale Measurements

A tipping bucket measurement device has been adopted at all JORDFORSK stations at the plot scale. This measurement device is relatively simple, robust and copes well with high sediment contents in runoff water. Runoff water is collected from the plots, travels through a closed pipe system into the measurement station, and is then collected into the tipping bucket. The tipping is automatically counted using a magnetic switch, and the number of tips is recorded every 10 minutes into a data logger. Water samples are collected in two sample containers positioned underneath the tipping bucket. A small gauge pipe, standing upright in each bucket yields an aliquot runoff sample each time the bucket empties.

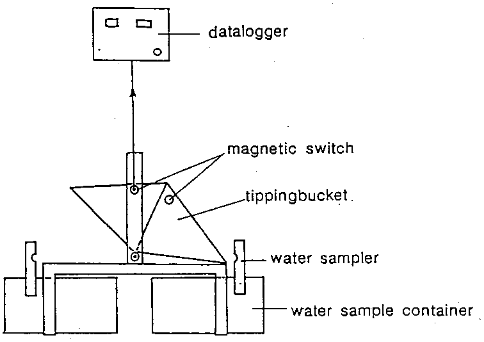

Figure 4. Schematic Representation of a Plot Scale Measurement Station

3.2.4. Vadose Zone Measurements

Four plots, 25 m² each, are established inside the sub-catchment. Two of the four plots are sown with the same crop as the sub-catchment, whilst the other two are left fallow. The following parameters are measured: soil suction at 5, 20, 40, 60 and 80 cm b.s.s. is measured with tensiomenters; soil nitrate content at different depths; leaf area index (LAI), crop height, crop production and nitrogen uptake by the crop at two week intervals during the growing seaon. Soil samples are taken and analysed for physical properties such as: pF, saturated hydraulic conductivity and texture. In addition climatological data are collected at a nearby meteorolgical station.

Measurement at this scale is, largely, aimed at quantifying water and nutrient transport in the vadose zone.

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SOIL CONSERVATION: IMPLEMENTATION OF MEASURES.

1. Introduction

Due to arising needs for a basis to perform soil conservation planning and cost efficiency analyses (both national and regional), JORDFORSK has developed a macro soil loss model. The model calculates soil loss (and loss of phosphorus) on agricultural land according to implemented conservation practices by the farmers, simulates implementation of conservation practices, and calculates needed implementation acreage given a certain soil loss level. A main feature of the model is its ability to manage adaptation of crop/tillage systems to erosion risk.

2. Overview

The model concept is based on the Universal Soil Loss Equation (WISCHMEIER 1978) and consists of three main modules:

1. Calculation of the erosion risk distribution based on soil erodibility and topography
2. Calculation at soil loss for a given crop/tillage acreage distribution and adaptation of crop/tillage practices to erosion risk.
3. Calculation of reduction in soil loss by simulating implementation of conservation practices, and calculation of needed conservation acreage given a target soil loss level.

A main property of the datasets accessible of regional and national level, is that there is no or poor knowledge of the erosion risk where the individual crop/tillage practices are executed. We have distributions of crop/tillage practices and soil/topographic properties, but no exact knowledge on how they are related. But in reality there are some links between crop/tillage systems and soil/topographic properties due to crop requirements and technical limitations. The model is designed to handle those kind of constraints on what crop/tillage practice the farmers would apply under which conditions.

Furthermore, due to an increasing environmental consciousness, the farmers might implement conservation practices and reallocate crops with the least erosion risk to fields with the highest erosion risk. This is introduced as "adaptation to erosion risk".

Distribution of erosion risk

This module calculates the distribution of erosion risk based on the distributions of soil erodibility, slope gradient, slope length and conditional sub-distributions between these factors, by adding up all possible combinations of the three factors. The distributions of soil erodibility and slope gradient is taken from soil surveys, but the distribution of slope length has to be estimated specially (e.g. map investigations, terrain models).

In addition, this module calculates erosion risk distributions within the distributions of soil erodibility, slope gradient and slope length, in order to handle special constraints between choice of crop/tillage systems and soil/topographic properties.

Adaptation of crop/tillage practices to erosion risk

A general way of managing adaptation of crop/tillage systems to erosion risk is implemented. The method consists of a set of crop/tillage systems (user specified) which participate in the adaptation, and a factor between zero and one for the degree of adaptation. The adaptation practices are distributed on the erosion risk distribution in two parts: an adaptive part (degree of adaptation x crop/tillage acreage) and a non-adaptive part. The non-adaptive part is together with the non-adaptive practices distributed proportionally to the erosion risk distribution. The adaptive part is distributed by locating the practices (successively in the list order) to the most erosive part left of the erosion risk distribution.

Simulating implementation of conservation practice

This module starts with a given crop/tillage distribution and moves acreage from one or more crop/tillage system to a target conservation practice in 10 steps, at each step redistributing crop/tillage systems to the erosion risk distribution according to soil topographic constraints, the list of adaptive practices and the degree of adaptation. If given a target soil loss level, the model calculates the acreage needed to achieve this level.

3. Erosion estimates and simulated implementation of conservation practices in south-eastern Norway

The model has been used in calculating the soil loss level (based on arbitrary yearly erosion conditions) in south-eastern Norway for three situations of crop/tillage distributions (mid 80's, 1993 and a predicted winter wheat acreage of 50,000 ha). From these situations, soil loss reduction for two conservation practices: (spring grain) spring tillage and gentle autumn harrowing has been simulated, and required implementation of these two practices is calculated for a given goal in total soil loss reduction (EGGESTAD 1994). The simulations have been carried out for two regimes of adaptation to erosion risk: (1) adaptation practices comprising autumn ploughing, autumn harrowing and spring tillage in spring grain, and (2) winter wheat in addition to (1). Results will be presented for the spring tillage measure, adaptation regime (2).

The following table shows the distributions of crop/tillage in the three situations:

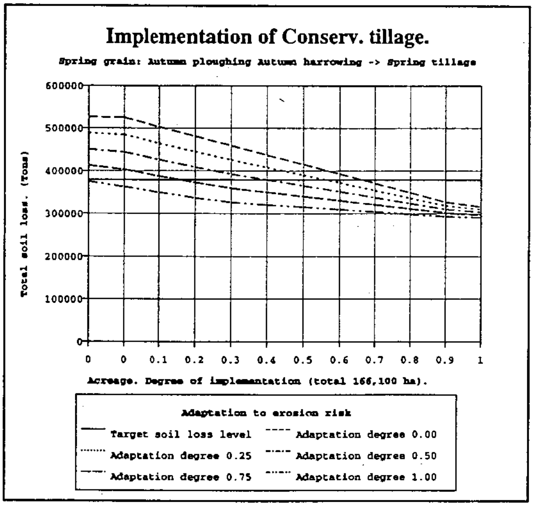
	Crop total ha	Tillage Aut. plough ha	Aut. harrow ha	Spring till ha	Direct drill ha
Sit. I.					
(Mid. 80's)					
Spring grain	297907	268266	5248	24185	210
Winter wheat	5245	5245			
Other arable	33275	21345	6670	5259	
Sum arable	336429	294857	11918	29444	210
Meadow	137934				
Sit. II.					
(1993)					
Spring grain	276053	152384	13667	107858	2144
Winter wheat	36588	36588			
Other arable	30447	15223	12179	3045	
Sum arable	343087	204195	25846	110903	2144
Meadow	131275				
Sit. III.					
(Predicted)*					
Spring grain	262640	130113	13003	117485	2040
Winter wheat	50000	50000			
Other arable	30447	15223	12179	3045	
Sum arable	343087	195337	25182	120529	2040
Meadow	131275				

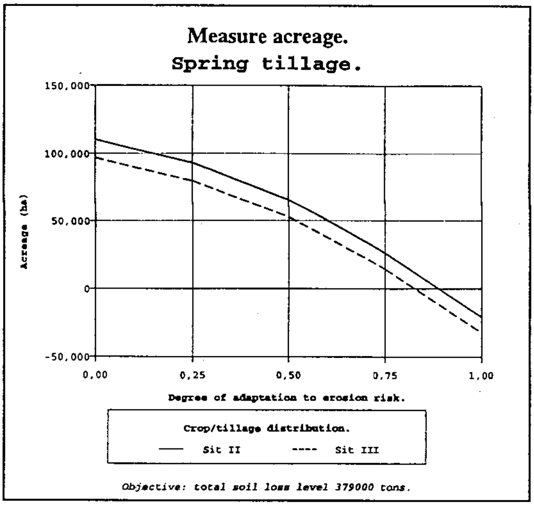
*: Crop/tillage distribution in 1993 with winter wheat acreage adjusted to 50,000 ha

The situation in the mid 80's is the bases for calculating the target soil loss level for the measures. The objective is to reduce the soil loss by an amount of 75 % of the maximum effect of no autumn tillage on all the spring grain acreage. From this, the target soil loss level is estimated to approx. 380,000 tons. This level is marked as a horizontal line on the next graph and is the target for the needs of measure implementation acreage in the last figure.

The following figure show the reduction in soil loss level as the implementation of spring tillage in spring grain increases for the situation in 1993. The simulation is performed for 5 adaptation degrees: 0 (random), f.25, 0.50, 0.75 and 1.0 (optimal).

The last graph presents the required measure implementation with origin in the crop/tillage distributions II and III. The acreage on the vertical axis is autumn ploughing and autumn harrowing converted to spring tillage (i.e. acreage in addition to the spring tillage acreage in the table). This figure demonstrates the importance of implementing the conservation practices to the fields with the highest soil erosion risk. With no adaptation of crop/tillage system to the soil erosion risk, implementation of spring tillage is required on additional approx. 100,000 ha while the reduced soil loss level would have been achieved if the spring tillage was applied on the most erosive fields corresponding to a degree of adaptation of 0,8-0,85.





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RUNOFF AND EROSION IN SMALL CATCHMENTS.

Runoff, erosion and nutrient leaching has been measured since 1986 in eight small catchments (0.3 - 3.2 ha). Each catchment was instrumented for measurement of surface runoff and water sampling. In one of the catchments drainage water was also measured. Volume proportional, mixed samples were taken during every runoff event or every day during snowmelt. In addition time programmed samples were taken especially during snowmelt and during the winterperiod. Total runoff were calculated and water samples were analyzed for suspended solids, nitrogen and phosphorus.

Marine sediments with clay loam and silty clay loam were the dominating soils. Cereals were grown in all catchments, and different tillage practices were either autumn ploughing, harrowing or no till cultivation.

PURPOSE: (i) Document runoff, erosion and nutrient losses from small catchments with different size, topography and cultivation practices. (ii) Study how hydrological factors influence runoff and nutrient losses. (iii) Study how different farming practices affect erosion losses.

Hydrology

Watersheds with many runoff events and high runoff intensities have greater risk of erosion than areas with few runoff events. The smallest catchments had fewest runoff events and shortest duration of time with runoff (TABLE 1). In 1987 and 1989 surface runoff lasted for 9 and 5 days for the smallest catchment 101, while the larger catchment 102 had 55 and 62 days with surface runoff. The smallest catchment had runoff only with snowmelt on frozen soil and in autumn period after several ongoing rainfalls. The catchments with valley depressions had a higher number of days with surface runoff. Highest runoff occurred in a catchment with levelled clay soil with low infiltration capacity and compacted soil structure.

Table 1: Annual number of days with runoff in different catchments. Catchment 107 are drainage water, the others surface runoff

Catch- ment	Area (ha)	1987	1988	1989	1990	1991	1992
101	0.4	9.0	30.2	5.3	16.3	12.8	23.4
102	3.3	55.6	68.0	62.2	48.4	37.1	49.4
106	0.9	61.5	70.8	69.7	53.5	39.5	50.2
107	0.9	104.4	160.4	104.1	70.3	85.7	72.2
108	0.4	36.9	44.5	41.2	23.6	25.8	31.7

Table 2: Total surface runoff (mm) 1987 - 1992. Station 107 is drainage water to catchment 106.

Catch-ment	1987	1988	1989	1990	1991	1992
101	33	102	71	127	31	52
102	88	97	30	128	29	36
103	0	0	10	121	27	21
106	238	292	178	216	242	158
107	357	404	123	54	165	93
108	188	327	130	232	244	146

Soil tillage and erosion

The catchments had different tillage practices from autumn ploughing to no tillage in autumn. Effect of grassed waterways, winter wheat and hydrotechnical means were also measured. Catchment 106 with the highest runoff had also highest erosion losses both with surface runoff and drainage runoff during years with autumn ploughing (TABLE 3). In 1991 and 1992 with no autumn tillage the erosion losses were small.

Table 3: Soil loss (kg / ha) 1987 - 1992.

Catch-ment	1987	1988	1989	1990	1991	1992
101	740	260	75	1520	80	1083
102	520	150	30	1570	10	20
106	2020	1860	720	2630	570	397
107	3010	2760	1420	310	340	120
108	1120	400	200	4940	840	3580

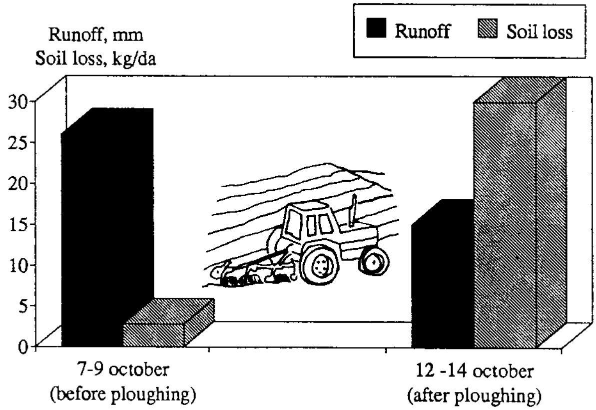

Figure 1. Runoff (mm) and soil loss (kg/ha) for catchment 108 before and after tillage 1987

Figure 1 illustrates how autumn tillage has affected erosion losses in catchment 108. A rainfall event October, 7-9 1987 gave 24 mm surface runoff and a erosion loss of 2 kg/ha. A new rainfall event after ploughing, October 12 - 14, gave 15 mm runoff, but the soilloss increased more than ten times. Catchment 106 was ploughed later at the end of October. During the mid-october events high runoff volumes gave minimal soil losses. After ploughing erosion losses were high with less runoff, the same pattern as for catchment 108 (TABLE 4).

Preferential flow and soil erosion to drainage system

In catchment 106 there was a similar pattern for loss of suspended material for both surface runoff and drainage water (TABLE 3 and 4). During the years with autumn ploughing 1987 to 1990 the maximum concentrations of suspended solids were more than 4000 mg/l for drainage water. In years with no tillage or meadow the concentrations never exceeded 800 mg/l.

Tracer studies with red dye confirmed the rapid water flow through cracks and backfill. Studies of soil structure in profile and in soil cores by computertomograph (CT) showed a compacted soil structure with a lot of cracks and macropores.

Table 4: Runoff (mm) and suspended solids (mg/l) in surface runoff and drainage water before and after autumn ploughing 1987

Date	Surface runoff (mm)	Susp. solids (mg/l)	Drainage runoff (mm)	Susp. solids (mg/l)
8 - 9/10	22.1	268	15.9	140
9 - 13/10	28.6	320	18.9	133
13 - 17/10	41.5	276	27.7	150
Ploughing				
17/10 - 2/11	2.0	2715	6.4	3800
12/11- 16/11	32.2	2265	33.4	4307
16/11- 23/11	3.0	2858	2.5	4184

Soil erosion during winter period

The highest erosion losses were measured in the winterperiod with rainfall on partially thawed soil. In catchment 108 rainfall in January with no snowcover gave runoff of 9 mm and a soil loss of 760 kg/ha. The surface was then icecovered. Snow fell on the ice covered surface and was then followed by rain. In a two-day period all the snow and the rain a total of 112 mm ran off. The first day the runoff was snow water with little particles, 25 mm runoff and only 2 kg/ha. The day after 77 mm surface runoff gave a soil loss of 3055 kg/ha. This was attributed to runoff from a upper unfrozen soil layer over frozen soil.

Table 5: Precipitation, runoff (mm) and soil loss (kg/ha) for catchment 108 winter 1990

Date	Runoff (mm)	Soil loss (kg/ha)	Precipitation (mm)
11/1 - 17/1			11.3
17/1 - 20/1	9	760	9.5
30/1 - 31/1	25	2	81.3
31/1 - 1/2	77	3050	30.2
1/2 - 2/2	42	445	4.3
2/2 - 4/2	17	150	9.9

Use of tracers for erosion studies

1. Use of ^{137} Cs for studies of erosion pattern in small catchments. In Catchment 102 75 soil cores to 40 cm depth are taken for Cs measurments in order to study differences in erosion and deposition in a catchment. The cores are sliced into 2 cm samples before measurment.

2. Use of ^{134} Cs for erosion and sedimentation studies. In a plot of 50 * 5 meter ^{134} Cs are spread on the surface on a autumn tilled soil. The plot has a vegetation zone of 5*5 m at the lower end. Cs activity is measured on the surface for every 1 m in the tilled soil and for every 0.5 m in the vegetated area and in surface runoff from the plot. The change in activity is measured after every large rainfall event and after the winter period. The purpose is to study the erosion and deposition processes of soil particles and the use of ^{134} Cs as a tracer for particle transport.

Rill and Gully erosion

Description of erosion pattern and measurment of rill and gully erosion is done for 23 catchments after exeptionally winter runoff with high erosion. The rills varied from a few cm in width to more that 5 m and with a depth down to the drainage pipes.

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MODELING SOIL EROSION IN COLD CLIMATE

Introduction

To describe the geo-biosphere process of soil erosion within the framework of a process based model is an important excercise in erosion research. In modeling all existing knowledge about the processes involved is linked together and the logic structure forced by modeling software will clearly show where severe lacks in knowledge exist. To construct a model is one possible method for achieving a better understanding of the functioning of a complex, multi process system such as soil erosion. Further, an erosion model based on process descriptions is an important research tool for predicting the effect of man-made changes inside the system (e.g change in agricultural practice) or the effect of changes in boundary conditions (e.g a climate change). The European soil erosion model EUROSEM (Morgan et al., 1994) represents such a process based erosion model. In this paper it is described why and how adaptions have to be made when using this model for cold climate conditions.

The effect of cold climate on the erosion process

The most important effect of cold climate on the water erosion process is given by the fact that water not only appears in the vapour and liquid phase, but also as ice, the solid phase. But as for all climate zones it is only the liquid phase that causes erosion. Temperature by itself does not have a significant effect on the erosion process. Figure 1 shows a simplified scheme of the erosion process and where ice formation has its effect. First of all, at low temperatures precipitation reaches the surface as snow, secondly hydraulic conductivity changes, and finally soil surface conditions change.

1. Precipitation as snow

During snowfall the kinetic energy of the precipitation can be ignored and one of the main causes of erosion, splash detachment of soil by rain drop impact is absent. In addition, a closed snow cover will absorb all kinetic energy of rain drops when raining. The snow cover built up during a cold period can be considered as a storage of precipitation on the soil surface and will be released again during a following snow melt period. The snowmelt period can be characterized as follows:

a. during the snow melt period a large amount of precipitation becomes available over a relatively short time period (in extreme situations, 3 month precipitation may be released in a 2 week period),
b. compared to the duration of a single rain storm, a nearly continuous supply of water at the soil surface takes place,
c. a high potential detachment by the runoff flow is realised,
d. a high potential total transport capacity (integrated transport capacity over time) arises.

e. the combination of topography and snow drift by wind (both during and after snow fall) causes an uneven distribution of snow and increases the variation in space of the surface conditions during snowmelt.

Although only detachment by flow is actual, high amounts of soil losses may be registrated because of the large transport capacity of the runoff. However, the remarks made in relation to infiltration (point 2) have to be taken into account.

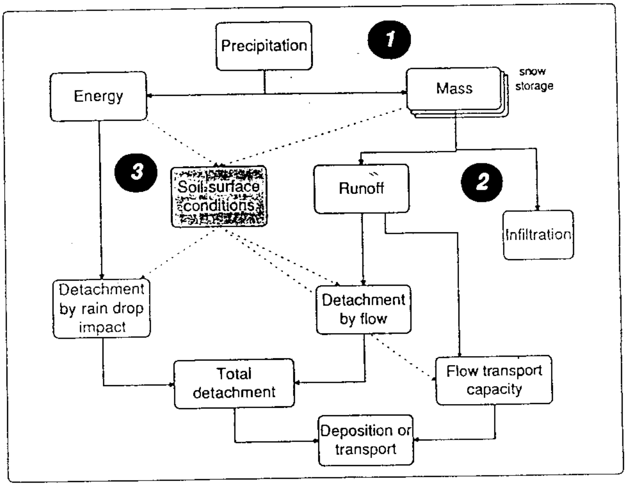

Figure 1. A simplified flow chart of the water erosion process. The numbers 1-3 mark where cold climate with ice formation will have an impact on erosion as discussed in this paper.

2. Infiltration into a frozen soil

Infiltration into frozen soils is a complicated process, and for a more detailed of this subject the reader is referred to Botterweg (1992). Ice formation in the soil matrix causes:

a. a redistribution of water to the ice front (the reason for frost heave),
b. cracking of the soil, depending on soil type
c. the final state as concerns infiltration, depends on the initial soil water content when freezing starts,
d. with discontinuity in freezing, e.g. a short period of thawing on the surface, water can fill the pores in the still frozen, deeper soil layers, and cause a complete blocking with ice of all pores and crackes in the soil.

These points show that the state of the soil at the beginning of e.g a snowmelt event, strongly depend on the combined hydrological and temperature regime during the past two to three months.

Infiltration capacity can not be derived from information about the soil type alone and it may vary from zero to more then the infiltration measured under unfrozen conditions for the saturated soil because of the macro-pores.

3. Soil surface conditions

Characteristics of the soil surface exposed to erosion will change by the formation of ice in the surface layer. The expansion of the volume at the transmission from the liquid phase to ice causes changes both at the micro and mezo scale. The changes may be summerized as follows:

a. a reduction of the surface storage caused by the expanding of the volume of larger pores during ice formation. Soil clods on top of surface "hills" are broken down and disappear into the depressions.
b. break down of soil aggregates is the same process as described above but on the micro scale.
c. Experimental work has shown that soil cohesion decreases as a function of the number of frost thaw cycles.
d. the erodability of frozen soil is zero, because the soil particles are strongly connected to each other by ice bridges or even completely embedded in ice.
e. during thawing of the soil, a thin layer of unfrozen, over-saturated soil may cover a still frozen soil layer. This thin layer will be highly erodable both by flow and as may occur, by splash.
f. frozen soil will have a very low Mannings-n value enabling a high flow velocity for runoff and thus a higher transport capacity.

The erodability of the top soil is temperature depending and changes from zero to a high value just in the moment of thawing. This change is likely to occur within a runoff event caused by snowmelt and the exact time is nearly impossible to predict. At that time a detachment limited erosion event suddenly changes into a transport limited erosion event. On sunny days the temperature of the top soil is more determined by radiation than air temperature. Combined with an uneven distribution of snow on the surface this will cause changes in erodability of the top soil over short (1-2 meters) distances, when there is a mosaic of bare soil and snow covered soil.

Using EUROSEM for cold climate conditions

At several points in the EUROSEM user guide, guidelines will be given on how to estimate necessary parameter values for winter/snowmelt conditions and how to modify/interpretate some of the input variables. An extra variable defining the depth of a non-erodable layer (e.g the upper frost boundary) had to be introduced in the model. EUROSEM only simulates single events and doesnot include soil temperature. It is therefor necessary to use a continuous hydrology and temperature model as e.g SOIL (Janssson,1992). The output from SOIL will give information about the state of the soil at the beginning and during a runoff event. As SOIL also simulate snow dynamics, snowmelt as a function of time becomes available and can be used as input instead of rainfall. Taken into account the remarks made above, EUROSEM (V3.1) has been tested on snowmelt events in Southern Norway using the measured hydrograph as input. The prelimenary results show that in principle EUROSEM can be used to simulate erosion under cold climate conditions, but parameterization is much more complicated because of the larger variation in both space and time of some of the key-parameters.

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SOIL MONITORING PROGRAM IN NORWAY 1992 - 1996

In 1992 the Ministry of Agriculture and the Ministry of the Environment started a nationwide program of agricultural soil monitoring. The program's primary objectives are:

* to give the public administration a basis to implement a cost effective environmental policy,
* to document the result of environmental efforts within agriculture due to the Ministerial Convention of the North Sea,
* to inform the agricultural industry about the environmental impact of agricultural practices and the result of the environmental efforts.

The program registers and reports the soil erosion and losses of nutrients from agricultural land in different regions. The information given is related to agricultural practises and environmental conditions. The development of the agricultural land is monitored to determine the effect of the measures taken to reduce the nutrient losses from the land.

The program will be extended to include toxic components, heavy metals, pesticides and other parameters related to the conservation of the productive agricultural land and the environment.

Structure of the program

The basis of the program is the monitoring of 9 streams, in rather small, predominantly agricultural catchment areas. The program also includes the monitoring of small plots of farm land and other specific investigations. Three of the nine catchment areas have been monitored since 1985, the other locations were started in the years 1991 - 1993.

The stream's catchment areas characterize different crop systems and climatic conditions in Norway. The catchments vary from 50 to 680 hectares and consist of 5 to 30 farms. The farmers give all information on farm practises e.g. ploughing, fertilizer use and irrigation, by keeping a record during the year. The technical standards of the silage and manure storage is also registered. The farmers run their farms without any particular consultation or restrictions on farming practices.

A Crump-overflow continually monitors the flow of water by taking samples that are proportional to water flow. The system is run by a data-logger. Calculations of the amount of chemical substances are based on the data registered and chemical analyses of the water samples taken.

The objective of sampling soil plots is to monitor losses of nutrients from different farming practices; manure spreading and erosion by different tillage practices. There are 8 plots of a size between 0.5 to 9 hectares. Some of these plots are within the catchment areas, some are located at other sites.

Information from 4 lysimeter research investigations is collected and reported through the soil monitoring program. The program includes investigations of 5 locations where different tillage practices are performed.

The water samples from the cachment areas and the small plots are analyzed for pH, total phosphorus, soluble phosphorus, ortho-phosphate, nitrate, nitrite, ammonium, suspended dry matter and potassium. Biological analyses of algae composition are carried out.

Data from the program is collected and processed by the institution responsible, furthermore the data are transferred to a central data base. Results from the program are to be reported annually, presented both as scientific papers and more technical reports.

Organisation of the program

Participants in the Soil Monitoring Program include Norwegian State Agricultural Research Stations, the Centre for Soil and Environmental Research, the Department of Soil and Water Sciences and the Department of Mathematical Sciences, the latter two at the Agricultural University of Norway.

The Ministry of Agriculture and the Ministry of Environment have the overall responsibility for the program and a professional council has a consultative function to the Ministries. The council represents the institutions involved in the program and the users of the information from the program. The Centre for Soil and Environmental Research is coordinating the program. Each institution is responsible for their own monitoring stations and small working groups are established to develop the program.

Some basic results

Nutrient losses and soil losses by erosion vary considerably between the years and between different locations. The largest nutrient losses are related to areas of intensive vegetable production. The vegetable areas are intensively fertilized and often located on light soil types readily exposed to leakage of nitrogen. The losses of nitrogen in the stream Vasshaglona in the southern Norway vary between 70 and 110 (average 90) kg per hectare and year. Phosphorus losses are between 1,3 and 9,0 (average 4,0) kg per hectare and year. The high losses are partly due to a high erosion rate in the stream itself.

Intensive dairy production with large amounts of manure has also a considerable potential of nutrient losses. The timing of the application of manure and the winter climate conditions affect the losses considerably. The losses of nitrogen and phosphorus from the stream Timebekken in southwestern part of Norway range from 40 to 113 (average 71) and 1,1 to 3,1 (average 2,2) kg per hectare and year, respectively. In an inland sheep and dairy-district with less rainfall, the stream Volbubekken shows minor losses. Nitrogen losses are between 5 and 40 (average 25) kg per hectare and year. Phosphorus losses are between 0,3 and 0,6 (average 0,4) kg per hectare and year.

Cereal crops such as barley, oats and wheat are major crops in south-eastern and central Norway. The losses of nutrients and soil erosion vary with soil type, topography and farming practice, and especially the time of ploughing. The losses of nitrogen from the stream Mørdrebekken in central south-east Norway shows hardly any variation during three years; average 17 kg per hectare and year. This is due to a silty soil with high available water capacity which ensures high yields. The losses of phosphorus are between 1,1 and 1,5 (average 1,4) kg per hectare and year. Losses from the stream Holobekken in central Norway are between 20 and 43 (average 33) kg nitrogen per hectare and year and 1,1 and 2,6 (average 1,7) kg phosphorus per year.

Investigations of small plots with different tillage practices have revealed that losses of soil through erosion processes varies tremendously, between 30 and 10.000 kg per hectare and year. The high losses of soil occurred on levelled land after autumn tillage of the soil. Investigations have shown that no tillage in autumn reduces soil and phosphorus losses by 80 to 90 %, and in addition nitrogen leakage by 15 to 30 %. Variations are due to soil types and winter conditions.

During recent years the farm practice concerning erosion in the cereal production areas in Norway has changed to a more environmentally sound practice. The autumn ploughing is replaced with spring ploughing, and winter wheat is more frequently sown as compared to previous years.

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SEDIMENTATION OF PHOSPHORUS AND SOIL PARTICLES IN CONSTRUCTED WETLAND

In 1990, four first order streams in South-Eastern Norway, were dammed up and their banks expanded. Four small, rectangular, shallow ponds resulted. Each had a 0.4-0.5 m deep vegetation filter, except at the inlet, where the sedimentation basins were 1 meter deep. The widths were 3-9 m, and surface area 230-860 m^2, equal to between 0.03-0.12 % of watershed area (50-100 ha). Average yearly discharge was 0.14 l/ha.

Samples were collected by a water proportional sampling system in the in- and outlet, with sedimentation traps throughout the constructed wetlands (CWs).

Retention of soil particles was higher in the "winter season" (November-April) than in the "summer season" (71 % versus 47 % respectively). The same was true for phosphorus retention (42 % versus 20 %). The corresponding values for organic matter were 27 and 17 %. High retention, despite winter storms, may be explained by a higher input of coarser soil particles, and little re-suspension due to vegetation cover.

Results from the "winter season" should, however, be used with some care: They include only one sampling season from two CWs (1993/1994). The "summer season" results include two seasons from four CWs (1992 and 1993). Higher retention in the "winter season" was confirmed by the sedimentation trap results.

Texture analysis of the sediment from the vegetation filter gave a clay content of 25 % on average. There were however, large differences between the CWs. The clay content was up to 5 times that expected from commonly used sedimentation theory. High content of clay and fine silt (18 %) may be explained as a function of vegetation reducing the water velocity, increasing flocculation, and the inflow of aggregated particles.

To sum up, these results show that even small CWs are able to retain soil particles and phosphorus. Constructed wetlands can be efficient tools to mitigate the effects of surplus nutrition loss and soil erosion from arable land.

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RUNOFF FROM DRAINAGE SYSTEMS, CONTENTS OF SOIL AND NUTRIENTS. MODELING CONSIDERATIONS.

Summary

Mean drain runoff at three sites in South-East Norway 1987-93 was 230-460 mm /year, and constituted from 55 to 90 % of total runoff. Precipitation was 700-850 mm/year.

The yearly drain runoff varied however between 80 and 680 mm/ year (27 to 95 % of total runoff). Monthly runoff decreased in this order: April, November, October, December, due to frost, snowmelt, precipitation and evapotranspiration.

Least drain water was found on artificially levelled silty clay loam soil low in organics (soil A), and most on loam soil high in organics (soil B).

Mean losses through drain water were: soil 26-1720, P 0.11-2, N 20-40 kg/ha/year. Mean concentrations were: soil 10-600, P 0.04-0.7 and N 6-15 mg/l. The highest numbers for soil and P were found on soil A, the highest for N were on soil B.

Soil type, time since drainage, tilling operations and hydrological conditions affected drain water composition, at least for soil and P. That is, processes both on soil surface, in plow layer and internal in soil affects drain water.

Concentrations (soil and P) also varied considerably over short time. N-leaching of fertilizer N happened after small amounts of excessive rain.

To explain this, soil must be considered to be heterogenious, and bypass flow has to occur. Subdrainage itself has a very heterogenizing effect on soil. This must be considered in hydrological, erosion and leaching models.

Drain water sampling must be volume proportional or frequent because of the shorttime variation.

Introduction

A large part of the cultivated area in Norway has been artificially subdrained, with drain spacings commonly 6-10 m and depth 0.8-0.9 m. This is due to humid climate and short growing season. It is important to know the amount and composition of drain water runoff, what factors that influence this water and what modeling considerations that should be made. Only amount of runoff, suspended solids, phosphorus and nitrogen will be discussed in areas within 50 km from Oslo.

Normal precipitation at Ås is 785 mm/year, mean temperature 5.5 degrees Celcius (-5.2 coldest month, 16.8 warmest month).

Methods

Drain- and surface water runoff have been studied in two field lysimetres and two catchments (2.7 and 9 hectares). Water sampling has mostly been volume proportional. Soil description follows below. The sites Syverud and Enerstu are both at Ås.

Table 1. Top soil information. Agrs = water stable aggregates. Level means that terrain has been levelled with bulldozer. Type: L=field lysimetre, C=catchment. Time=year since drainage TotC=total carbon, TotP=total P, pF0-2=volume pF 0 to pF 2.

Site	Type	Time [years]	Soil	Level	Clay [%]	Silt [%]	Agrs [%]	TotC [%]	TotP [mg/kg]	pF0-2 [%]
Holt	C	14	A	Yes	28	67	-	1.5	863	11
Askim	L	5	A	Yes	29	60	30	1.1	715	9
Syverud	L	>30	B	No	23	50	83	3.2	970	16
Enerstu	C	20	B	No	21	41	-	2.6	1370	15

On sites Holt, Askim, Syverud there has been spring grain growing and used artificial fertilizer: N=21%, P=4%, K=10%, about 100 kg N/ha/year. Site Enerstu has received large amounts of slurry about every third year.

Results

*Table 2. Mean runoff values 1987-93, % of total runoff, precipitation for 3 sites. *) not measured at site.*

Water type	Askim		Holt		Enerstu	
	[mm]	[%]	[mm]	[%]	[mm]	[%]
Drain water	296	55	230	70	461	91
Surface water	242	45	97	30	47	9
Precipitation	850*)		700*)		838	

Table 3. Yearly drain runoff values at 3 sites (mm, and % of total runoff) and yearly precipitation in mm.

Site		1984/85	1986	1987	1988	1989	1990	1991	1992	1993
Enerstu	[mm]	378	312	675	670	369	412	364	444	285
	[%]	72	62	96	93	95	88	81	93	88
Holt	[mm]	270	225	425	430	240	80	170	170	140
	[%]	66	62	86	86	92	27	52	62	65
Askim	[mm]	-	-	425	310	250	370	315	330	195
	[%]	-	-	61	44	62	58	56	65	52
Precipitation at Enerstu	[mm]	834	709	977	986	741	890	745	802	728

Table 4. Monthly drain water runoff at two sites (mm, and % of total runoff). Monthly precipitation at Enerstu in mm.

Site		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Enerstu	**[mm]**	24	35	31	78	17	12	9	27	23	60	71	44
1984-93	**[%]**	64	84	58	73	------100%------			92	98	93	98	86
Askim	**[mm]**	4	11	20	61	13	10	10	21	20	38	66	23
1987-Ap-94	**[%]**	18	18	32	56	85	74	76	69	80	63	87	43
Precipitation Enerstu	**[mm]**	68	50	70	47	40	74	89	122	74	116	93	69

Tables 2, 3 and 4 show measured drain runoff values as means for a periode, yearly means and monthly means respectively.

Askim and Enerstu have the same climate. Drain runoff is lowest and therefore infiltration must be lowest at Askim (levelled silty clay loam, low aggregate stability). Table 4 shows that drain runoff occurs all months but decreases in the following order: April, November, October, December. This is due to frost, snowmelt, evpotranspiration and precipitation. The difference between soil types was greatest in winter when soil was partly frozen.

Table 3 shows considerable yearly variation in drain runoff both in absolute and relative terms. The differences are caused by precipitation, soil types, snow cover and depth of frost in soil.

Table 5. Runoff, losses and concentrations in drain water 1991-93 for 3 sites. Soil type, tillage and years since drainage are given.

Site	Soil	Years	Tillage	Runoff [mm]	Losses in kg/ha/year		
					Soil	P-tot	N-tot
Askim	A	5	Plow. autumn	287	1720	2.05	18
Holt	A	14	Plow. autumn	159	240	0.32	21
Syverud	B	>30	Plow. autumn	320	38	0.13	51
Syverud	B	>30	Plow. spring	250	26	0.11	37
					Concentrations in mg/l		
Askim	A	5	Plow. autumn		599	0.71	6.3
Holt	A	14	Plow. autumn		150	0.20	13.3
Syverud	B	>30	Plow. autumn		11.8	0.040	16.0
Syverud	B	>30	Plow. spring		10.3	0.043	14.8

Wellstructured soil with old drains (Syverud) clearly had the lowest losses and lowest concentrations of soil and P, but N-losses were highest due to high content of organics. Spring tillage gave lower drain runoff and lower N-losses than autumn plowing at Syverud. The difference was greatest at shallow frost.

Composition of drain water thus varies greatly and depend on soil type, time since drainage, tillage and precipitation in addition to other factors.

Table 6. Example of tillage effects on P-content (mg/l) in drain water 1987-88 by comparing two sites. Site Gefo-106 (Øygarden, 1989) has same soil type and climate as Holt.

HOLT, DRAINED 14 YEARS AGO			GEFO 106, DRAINED 2 YEARS AGO		
Periode/tillage	**Surface**	**Drain**	**Periode/tillage**	**Surface**	**Drain**
Snowmelt	0.8	0.35	**Snowmelt**	0.8	0.77
Growing season	0.72	0.20	**Grow season**	0.77	0.64
After harr. aut.	1.41	0.55	**Stubble**	0.29	0.27
After plowing aut.	2.5	0.75	**After plowing aut.**	1.9	1.8

Table 6 shows that both surface and drain water is affected by tillage operations. This means that particles and particulate P from surface and plow layer could reach the drain system, especially on newly drained clay soils. At Syverud (soil with high aggregate stability, old drains) P-reaction on tillage was much less.

From table 7 it is seen that N-concentrations increased in May and June after fertilization and after some extra drainwater caused by rain. The drain runoff is so small that according to piston theory, the new N-rich water should not have reached the drains yet.

Table 7. Example of leaching of fertilizer N caused by bypass flow. Site: Holt, year 1987. Fertilizer added in may.

Period	**Drain runoff [mm]**	**N-conc. [mg/l]**	**N-loss [kg/ha]**
January-april	119	7.3	8.7
May	2.5	24	0.6
June	40	48	19.2
July-december	218	2.1	4.5

Table 8. Examples of hydrological effects on P-concentration in drain water. Holt, May 1993. The soil had been tilled.

Hydrologic condition	**5.-6. of May**		**7.-8. of May**	
	Intensity	**P-conc.**	**Intensity**	**P-conc.**
Increasing or high	1.8 mm/day	0.7 mg/l	4.8 mm/day	0.53 mg/l
Decreasing or low	0.34 mm/day	0.07 mg/l	0.6 mm/day	0.04 mg/l

At Holt, drain water always responded to runoff condition, but not always as clearly as above. At Syverud there was much smaller response. Sampling procedures for drain water must consider this large and fast variation in water quality.

Several of the above findings, indicate a direct fast connection between surface and/or plow layer to the drains. That is, the soil must be considered heterogenious. Cracking, draining and tilling are heterogenizing processes/operations. Table 9 summarizes some effects of heterogenious soil.

Table 9. Conceptual model, explaining drain water response.

Property	(H) = Homogenious	(N) = Nonhomogenious soil
Flow type	Piston	As (H), but also bypass.
Response time on precip	Dep. on saturation	As (H), but also depends. on rain intensity
Solute speed	Rel. slow (brake through)	Slow or fast (dep. on rain intensity).
Filtering property	"Perfect"	Not "perfect"
Source of particles in drain water	Internal in soil, (near pipes)	As (H),but also surface, plow layer, macropores
Reason for drain particle variat.	Texture, structure, runoff intensity	As (H),but also tilling, time since draining etc.
Main soil loss route	Surface runoff	As (H), but drains may also be important.
Water affected by surface operations	Surface water only	As (H), but also drain water may be affected.

References

Øygarden, Lillian (1989): Utprøving av tiltak mot arealavrenning i Akershus. Handlingsplanen mot landbruksforurensninger. Rapport nr. 6. GEFO/JORDFORSK.

Soil Scientist Helge Lundekvam
Agricultural University of Norway
Dept. of Soil and Water Sciences
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ANNOUNCEMENTS

EUROPEAN SOCIETY FOR SOIL CONSERVATION

Meeting on

THE SOIL AS A STRATEGIC RESOURCE: DEGRADATION PROCESSES AND CONSERVATION MEASURES

Tenerife-Fuerteventura-Lanzarote (Canary Islands, Spain), 11-15 July. 1995

2nd Circular

The ***main subject*** to be discussed at this meeting will be the Conservation of the Soil as a Strategic Resource in relation to:

a) Water and eolian erosion processes and other processes of physical degradation as a consequence of the abandonment of traditional agricultural practices.
b) Salinization-sodification processes related to irrigation agriculture and the use of low-quality water.
c) Chemical pollution and acidification (chemical time bomb) as a consequence of the intensification of agriculture.
d) Measures of environmental protection and of soil and water conservation in fragile ecosystems.

Host institution: University of La Laguna at Tenerife (Canary Islands).

Official Language: The official languages of the Meeting are English and Spanish, only for the presentations. The printed material will be in English. Translations will be provided.

Preliminary Programme:

July 10 (Monday):	Arrival of the participants to the Tenerife Airports. 10 am - 20 pm Registration and documentation.
July 11 (Tuesday):	Opening Ceremony and scientific sessions (paper and poster) on subjects a-b.
July 12 (Wednesday):	Scientific sessions (paper and poster) on subjects c-d. ESSC Council Meeting.
July 13 (Thursday):	Field trip in Tenerife: Experimental plots for measuring water erosion (Andisols and Aridisols).
July 14 (Friday):	Departure to Lanzarote or Fuerteventura. Field trip in Lanzarote (Conservation agriculture in arid zones) or Fuerteventura (Soil degradation processes due to erosion and salinization).
July 15 (Saturday):	Field trip in Lanzarote or Fuerteventura.

General information

1) The technical sessions will take place at the University of La Laguna (Tenerife) or at the conference rooms of a hotel in Puerto de la Cruz where accommodation is arranged for participants.
2) Tenerife-Lanzarote and Fuerteventura-Tenerife transfers will be by air, while Lanzarote-Fuerteventura transfers will be by ferry.
3) Tenerife is connected by air with the main European capitals by the Reina Sofia (Tenerife South) International Airport. The possibility of organizing charter flights with the main European cities is being explored for this meeting.
4) A scientific committee, under the auspices of the ESSC, has been constituted to select the works to the published in the Proceedings of the Meeting, as follows:

R.P.C. MORGAN. Silsoe College, U.K.	N. MISOPOLINOS. Thessaloniki, Greece
J.L. RUBIO. IATA, Valencia, Spain	D. GABRIELS. Ghent, Belgium
J. POESEN. Louvaine, Belgium	G. RICHTER. Trier, Gemany.

Expected Registration Fees

- Registration fee for ESSC members:	235 US $ (360 DM / 30.000 ptas.)
- Registration fee for ESSC members:	315 US $ (480 DM / 40.000 ptas.)

For further information please contact: Prof. Dr. Antonio Rodríguez Rodríguez, President of the Organizing Committee, Dpto. Edafología y Geología, Fac. Biología, c/Astrofísico Francisco Sánchez s/n. 38204, Universidad de La Laguna, Tenerife, Canary Islands, Spain. Telephone: 34-22-603741. Fax: 34-22-253344. E-mail: ARODRIGUEZ@ULL.ES.

✂ ....

Registration Form:

Family name: ______________________ Name: ______________________

Organization: ____

Address: ____

Postal Code: ______________ City: ______________ Country: ______________

Fax: ______________ Phone: ______________ E-mail: ______________

ESSC member: ☐ YES

☐ NO

Date: ______________ Signature: ______________________________

Please return the registration form to: Prof. Dr. Antonio Rodriguez-Rodriguez

EUROPEAN SOCIETY OF SOIL CONSERVATION

Academy of Natural Sciences of Russian Federation

Soil Science Society of Russia, Moscow State University

Workshop on

PROBLEMS AND MANAGEMENT OF SOIL CONSERVATION IN EUROPE.

Moscow (Russia), 18-24 September 1995

The ***main objective*** of the workshop is to streng then discussion on the problems and management of soil conservation in Europe.

The ***main topics*** of the workshop are:

(a) Causes of soil erosion in different countries.

(b) Prediction of soil degradation and conservation planning.

(c) Organisation of soil conservation in european and other countries.

Host institute: Faculty of Soil Science, Moscow State University.

Venue of the workshop: Holiday Hotel "Kultyshevo", Moscow region (40 km to the west of Moscow, 30 km from the airport Sheremetyevo).

Main Programme

September 18 (Monday)	Arrival and registration of participants.
	ESSC Executive Committee meeting.
September 19 (Tuesday)	Opening ceremony and paper session.
September 20 (Wednesday)	Paper session.
September 21 (Thursday)	Bus trip to Dmitrov (60 km from Moscow):
	Erosion and degradation affected soils.
September 22 (Friday)	Bus trip to Puschiono (120 km from Moscow):
	Visit at the Institute of Soil Science and Photosythesis.
	Field excursion: ancient and modern gully erosion.
	Visit at bioshere reserve.
September 23 (Saturday)	Paper session. Closing ceremony.
September 24 (Sunday)	Departure of Participants.

Evening programme

September 18 (Monday)	Visit at the Moscow State Circus perfomance.
September 19 (Tuesday)	Visit at the Bolshoy Theatre perfomance.
September 20 (Wednesday)	Visit at the Moscow Kremlin and the Diamond Fund.
September 21 (Thursday)	Visit at the Tretiakov Picture Gallery and symphony concert.
September 23 (Saturday)	Views of Moscow - bus excursion. Banquet.

Language of the workshop - English. The Abstracts volume will be avalable for Participants during Registration. Full text of paper presentations after revision will be published in russian magazine *POCHVOVEDENIJE* (Soil Science).

Expected ***costs of the workshop***: Regestration fees:

- for ESSC members and accompanying persons.... 130 US $
- for non-members .... 180 US $
- for students .... 90 US $

It includes: services of the workshop secretariat, workshop facilities, book of abstracts, coffee breaks.

Accomodation: Single and double rooms with individual toilet facilities and bathrooms: 25-30 US $ per day. Telephones for making and receving calls are available. Medical servicesd are available. Breakfast, lunch and dinner in the hotel: 20 - 30 US $ per day.

Banquet: on September, 23 (Saturday) in the hotel: 15 US $

Bus services: Mean european prices for public transport, depending on number of participants. All participants will be picked up in the airport and delivered directly to the hotel. Back delivery to the airport is also guaranteed.

Organizing committee:

Chairman:	Prof. M.S. Kuznetsov.
Sekretary:	Dr. W.M. Goncharov.
Treasure:	Prof. Dr. G.P. Glazunov
Scientific programme organizers:	Prof. I.I. Sudnitzin; Prof. E.V. Shein.
Scientific bus trips organizers:	Prof. A.I. Pozdnjakov; Dr. V.V. Demidov.

....

EUROPEAN SOCIETY OF SOIL CONSERVATION

Academy of Natural Sciences of Russian Federation

Soil Science Society of Russia, Moscow State University

Workshop on

PROBLEMS AND MANAGEMENT OF SOIL CONSERVATION IN EUROPE.

Moscow (Russia), 18-24 September 1995

Prof./Dr./Mr./Mrs.: .... ESSC member ❑

Address: .... Non member ❑

.... Student ❑

....

❑ I wish to attend the workshop.

❑ I wish to attend the workshop and to present a paper

Title of the paper: ....

....

Date: .... Signature: ....

To: Prof. M.S. Kuznetsov; 119899 Moscow, Russia: Moscow State University, Fac. of Soil Science; Tel.: (095) 939-59-29, Fax: (095) 939-09-89

INTERNATIONAL SYMPOSIUM ON SOILS WITH GYPSUM

Lleida, Catalonia (Spain), 13-19 September 1996

1st Circular, September 1994

Location

This Symposium will be held in Lleida (Catalonia), the center of a prosperous agricultural region under irrigation, with a mediterranean semi-arid climate in the Ebro Valley. Being Spain the european country where gypsiferous soils are most extensive, the Symposium offers an excellent opportunity to see a wide variety of soils with gypsum with respect to their origin, behaviour, landuse and management.

Pre-Program

13 September Reception in Lleida.

14-15 September **Symposium papers. Sessions:**

I. Landforms, processes and characteristics.
Characteristics, morphology, distribution and mapping of soils with gypsum, geomorphic processes, advances on classification of soils with gypsum, ecological aspects

II. Methodology and techniques of study.
Micromorphological approach, submicroscopic techniques, analytical aspects.

III. Behaviour and management
Soil water behaviour of soils with gypsum, dryland farming management, irrigation and drainage systems, erosion control, management in civil engineering and landuse planning, soils with gypsum as a media for acceptance of waste.

16-19 September **Field trips.**

Soils on tertiary gypsum outcrops: The Barbastro-Balaguer anticline.
Gypsic and Hypergypsic horizons under irrigation: The irrigated area of the Urgell channel.
Petrogypsic horizons and the recent irrigation projects in the rainfed area of Algerri-Balaguer.
Gypsiferous soils and salinity in Quinto, Zaragoza.
Soil with gypsum of Ciudad Real.

20 September Departure from Madrid

Deadlines

If you want to receive the second circular return the attached form before June 95 to the following address:

R.M. Poch; Secretary ISSWG; Dep. Medi Ambient i Ciències del Sòl, UdL; Av. Rovira Roure 177; 25198 - Lleida, Catalonia. Phone: +34 73 7025567; Fax: +34 73 238264.

Abstracts will be requested by 1st February 96.

Papers

Invited plenary papers corresponding to the main topics will be presented. Prospective authors are invited to submit abstracts that will be presented either in oral sessions or in poster sessions, which will be published in the book of abstracts of the Symposium. Oral and poster communications will be submitted to referees and, in case of being accepted, published as a book on Soils with Gypsum by international publishers.

Language

The official language of the Symposium will be english. Communications will exceptionally be allowed in the other three official languages of the International Society of Soil Science: spanish, french and german. The Book on Soils with Gypsum will be published in english.

Organizing Committee

Chairman: Prof. Dr. J. Porta.
Department of Environment and Soil Science, Universitat de Lleida.

Vice-Chairman: Dr. J. Herrero.
Servicio de Investigación Agraria, Diputación General de Aragón, Zaragoza.

Secretary: Dr. R.M. Poch.
Department of Environment and Soil Science, Universitat de Lleida.

✂ ....

INTERNATIONAL SYMPOSIUM ON SOILS WITH GYPSUM

Lleida, Catalonia (Spain), 13-19 September 1996

RM Poch, Av. Rovira Roure 177; 25198 - Lleida, Catalonia, Spain. Tel: +34 73 7025567 Fax: +34 73 238264.

Pre-registration form.

Please return before June 95 if you want to receive the Second Circular, to the Secretary of ISSWG.

Name: .... Title: ....
Affilation: ....
Address: ....
Country: ....
Phone: .... Fax: ....

The probability that I will attend the Symposium is:
❒ High ❒ Moderate ❒ Low.

The probability that I will present a communication is:
❒ High ❒ Moderate ❒ Low ❒ None

In which Session of the program would you like to present a communication?
❒ I Landforms, processes and characteristics.
❒ II Methodology and techniques of study
❒ III Behaviour and management
Title: ....
.... ❒ Oral ❒ Poster

EUROPEAN SOCIETY OF SOIL CONSERVATION

Second International Congress

DEVELOPMENT AND IMPLEMENTATION OF SOIL CONSERVATION STRATEGIES FOR SUSTAINABLE LAND USE

Technische Universität München Weihenstephan (Germany), 1-7 September. 1996

2nd Circular

Theme

In spite of a strong public awareness of environmental problems, soil conservation is still not realized in politics, administration and practical soil use. Old threats such as soil erosion continue to challenge while new problems, such as the emission of atmospheric trace geases, emerge. Knowledge about the processes involved and appropriate protection measures should be gathered and shared among all those, who are responsible for soil conservation to ensure sustainable soil use.

Sessions

The congress is composed of four sessions. Each session will begin with an invited keynote address.

Session 1: Soil compaction and structure deterioration. Convener: M. Kutilek, Prague.

Session 2: Soil contamination (heavy metals, acidification, xenobiotics).
Convener: R. Prost, Versailles.

Session 3: Strategies to minimize soil erosion and ecological side-effects.
Convener: F.J.P.M. Kwaad, Amsterdam.

Session 4: Soil consumption (use of peat, loam etc., construction site losses).
Convener: R. Häberli, Berne.

Oral or poster presentations on these and other related topics are welcomed.

The achievements of the Congress will be summarized in a publlic workshop on the last day.

The ESSC conference will be followed by a conference of the International Soil Conservation Organization ISCO in Bonn (germany). The ISCO conference will focus on the global instead of the European view.

The delegates of the ESSC conference are encouraged to also attend the ISCO conference.

Abstracts

Abstracts of one page length (300 words maxium) for both oral and poster presentations should be sent to the Congress Treasurer by Dec. 31, 1995. Abstracts should include the title, author(s), institution address(es), and proposed session number. The abstract should be concise and cover the main points of the presentation. Abstracts should not include references, diagrams or drawings. A book of abstracts will be distributed to delegates upon registration.

Oral Presentation

Each Presentation will be allocated 20 minutes, including time for discussion. Keynote presentations will be allocated 30 minutes.

Poster Presentation

Posters will be displayed in the main hall. Time will be allowed for discussion of the poster presentations. Cork display boards are 150 cm high and 85 cm wide. Fixing material will be provided.

Congress Proceedings

Poster and oral presentations may be published in English in a special issue of *Soil Technology* after passing the usual reviewing process. Detailed guidlines for the preparation of the manuscripts are given in the inside cover of *Soil Technology* and can be obtained from *Elsevier*.

Three copies of the paper must be delivered to the Congress Secretary NOT LATER than at the congress. The authors are encouraged to include a floppy disc together with the paper copy of their manuscripts.

Pre-Congress Tour: Hallertau and Danube Valley, Sept. 1st

The price is DM 40 and includes transportation, lunch package and tour guide.

Mid-Congress Tour: Scheyern Experimental Farm, Sept. 4th

The price is DM 40 and includes transportation, guide, lunch and beverages.

Post-Conference Tour: Nationalpark Berchtesgarden, Sept. 6th-7th

The price is DM 185 and includes bus transfer, overnight stay in double rooms with shower incl. dinner and breakfast, ticket for the cable tram, lunch package and a tour guide. A maximum of 20 single rooms are available for an additional charge of 30,- DM.

Please confirm your trip not later than the 31th of October. Maximum participants: 40.

This tour will end in Freising, where we arrive at about 19°°.

Location and Infrastructure Accomodation

The campus ("Weihenstephan"), 30 km NE of Munich, can be easily reached by plane (5 km to Munich International Airport), by train (1 km to the railway station in Freising) or by car (10 km to nearest freeway).

Temperature in early September ranges between 10 °C (night) and 20 °C (day). More than 10 mm of rain can be expected only once a fortnight.

Accomodation

A variety of accommodations is available in different class hotels in Freising (40 000 inhabitants), prices ranging from 70 to 200 DM (bed & breakfast). A list of hotels together with prices, telephone and FAX numbers will be distributed together with the congress guide (mailing in May 1996).

Visits

Several research institutions focusing on soil research are located in the Munich area:

- Bayrische Landesanstalt für Bodenkultur und Pflanzenbau (Bavarian Department of Soil Technology and Agronomy)
- Institut für Bodenökologie im Forschungszentrum für Umwelt und Gesundheit GSF (Institute of Soil Ecology at the reseach Center of Environment on Health)

- Institut für Bodenkunde der Forstwissenschaftlichen Fakultät (Department of Soil Science at the Faculty of Forest Sciences)
- Bayrische Geologisches Landesamt (Bavarian Geological & Soil Survey)

Contacts can be made with these institutions upon request in advance.

Congress Banquet

Evening dinner with Bavarian specialities an Bavarian folk music at Schloß Hohenkammer, a castle originating from the 15th century. Price: DM 80.

Registration Fees

Members of ESSC: .... DM 180
Non-members .... DM 200
Students .... DM 100

These fees include lunch, congress abstracts, and congress foulders. The congress tours and the social event will be charged seperately. The payments must be made exclusively in German Marks (DM) by March 31, 1996 by remitting the amount to Account No. 400 100 1, Code word 'ESSC-96; AST-Nr. 820 296-2' with the Bayrische Vereinsbank, Freising, Germany or by sending a collection-only cheque made payable to 'Lehrstuhl für Bodenkunde TUM'.

Cancellation: In case of cancellation later than March 31, 1996, no registration fees will be refunded. Befor this closing date, 75% will be refunded.

Letter of invitation: A letter of invitation will be sent upon request.

Accompaning Persons

Visits to places of interst in Munich or to some of the Bavarian castles can be arranged when requested in advance. A theatre performance in Munich may also be considered.

Deadlines

Please complete and return the attached form. Deadlines are:

- Registration for post-congress tour .... 31 Oct. 1995
- Registration for presentation .... 31 Dec. 1995
- Notification about acceptance .... 28. Feb. 1996
- Registration for congress and tours .... 1 April 1996
- Mailing of congress guide .... 31 March 1996
- Submitting full papers .... at the Congress.

Organizing Committee

Chairman:	Prof. Dr. U. Schwertmann
Secretary and Organizer:	PD Dr. K. Auerswald
Treasurer:	Dr. H.H. Becher
Conference Tour Organizers:	Mr. M. Kainz, Dr. H. Stanjek, Prof. Dr. J. Pfadenhauer.

REGISTRATION FORM

Title (Mr./Ms./Mrs. + Prof./Dr. or the like):

....

Surname: .... First name: ....

ESSC-Member (yes/no): ......

Institution: ....

....

Road or P.O.Box:

Place incl. CIP:

State: ....

Accompanying persons: ....

1 Surname: .... First name: ....

2 Surname: First name: ....

3 Surname: .... First name: ....

First Author (y/n): ......Presentation(s); **Oral** / **Poster** (o/p): ....

Title of Paper: ....

....

....

Co-author Name(s): ....

Participating in Tours etc. (y/n): ......

Pre-Tour (y/n): ...... Pers.: ......

Mid-Tour (y/n): ...... Pers.: ......

Post-Tour (y/n): ...... Pers.:

Dinner (y/n): ...... Pers.:

Fees (DM):		Member	acc.Pers.	Non-Member	acc.Pers.
	Conference:	180.00	0.00	200.00	0.00
	Pre-Tour:	40.00	40.00	50.00	50.00
	Mid-Tour:	40.00	40.00	50.00	50.00
	Post-Tour:	185.00	185.00	200.00	200.00
	Dinner:	80.00	80.00	80.00	80.00

Total: ....

!! Please return to:

Dr.H.H.BECHER
Lehrstuhl für Bodenkunde
Technische Universität München
Weihenstephan 1

D-85350 Freising
Germany

NOTICE RECEIVED

Jorndas Multidisciplinares Sorbre
INCENDIOS FORESTALES EN LA COMUNIDAD VALENCIANA
UNIVERSIDAD POLITÉCNICA DE VALENCIA

Las Jornadas Multidisciplinares sobre Incendios Forestales, 20 y 21 de octubre, organizadas por el Área Ciencia-Tecnología-Sociedad de la Universidad Politécnica de Valencia han contado con una participación superior a 240 personas. Los 25 ponentes provienen de un amplio abanico de disciplinas: la investigación, la Universidad, las Administraciones Públicas, la empresa y los movimientos sociales. Concretamente: European Society for Soil Conservation, Consejo Superior de Investigaciones Científicas (CSIC), Xunta de Galicia, Generalitat Valenciana, ICONA, Protección Civil, Papelera Peninsular, E.N. Bazán, MAPFRE, Sema Group, Natura Consultores, Universidades de Alicante, Autónoma de Madrid y Politécnica de Valencia, Consorcio de Bomberos de la Diputación de Valencia, Greenpeace, CECU, Acció Ecologista Agró y medios de comunicación.

El encuentro ha sido clausurado por el Rector, Justo Nieto, quien ha anunciado la creación en la Politécnica de un centro de estudios e investigaciones sobre problemas relacionados con la protección de los bosques.

Una síntesis provisional de las ponencias y los debates destacaría:

- El futuro del territorio valenciano está abierto. Puede ser un futuro con bosques o puede ser un futuro calcinado. En principio, es importante declarar la impotencia, predominante hasta el momento, frente a la amenaza del fuego y la desertificación. Y también lo es negarse a tolerar pasivamente el que los montes valencianos vuelvan a ser noticia, un verano tras otro, en los mismos términos, o parecidos, que lo han sido en los meses de julio y agosto últimos.
- De acuerdo con lo anterior, se requiere y es necesario exigir:
  - ★ Una fuerte voluntad política que se prolongue más allá de los ciclos electorales.
  - ★ Un liderazgo genuino, comprometido y reconocible en condiciones de movilizar medios y educar, hacer participar y promover cambios en los hábitos sociales.
  - ★ Crear las condiciones que permitan perseguir y hacer justicia a los delitos ecológicos.
  - ★ Invertir en I+D, así como en innovaciones que aligeren y eliminen el azote del fuego y la amenaza de desertificación. Empleo de las mejores tecnologías para la prevención, la detección y la extinción del fuego, así como para la regeneración del monte.
  - ★ Mejorar la comunicación y enriquecer el debate entre los profesionales y los colectivos comprometidos en la conservación del bosque, a fin de incrementar las sinergias entre los mismos. Crear y favorecer lazos de cooperación entre las Administraciones Públicas, las Universidades, las empresas, los expertos, los profesionales, la población rural y todos los ciudadanos interesados en el futuro de sus bosques.

- ★ Convencer y convencerse de que estamos ante una emergencia social que ha de afrontarse como una cuestión de estado que requiere una planificación, una organización y un despliegue operativo acorde con la dimensión del problema y sus características, que exigen criterios de solvencia, participación social, respuesta rápida y perseverancia.

- ➢ Finalmente, entre las instituciones implicadas en el problema de los incendios, a la Universidad le corresponde un papel específico que consiste en actuar de nexo de unión entre conocimiento y valor. La evaluación social de la magnitud del desastre que suponen el fuego forestal y la desertificación es tan importante como los conocimientos (tecnologías) necesarios para afrontarlos.

CIENCIA-TECNOLOGÍA-SOCIEDAD
Valencia, 24 de octubre de 1994

THESIS: SOIL EROSION ASSESMENT USING GIS. APPLICATION TO MADRID REGION IN CENTRAL SPAIN

Summary

Water erosion in the "Comunidad de Madrid" region (central Spain) has been evaluated developing a methodology that allows to apply two erosion models using Geographic Information Systems.

One model correspond to the qualitative methodology defined in the project "Soil erosion risks and important land resources" from the CORINE program; the other to the quantitative method established by the Universal Soil Equation, USLE.

In order to apply those two models, two Geographic Information Systems have been used simultaneously, one with vector data model called PC/ARCINFO and another with raster data model called IDRISI.

A methodology has been developed, and has been applied to the "Comunidad de Madrid" geographic area, allowing: the creation of a data base with precise information for the application of the models; the acquisition of all the parameters involved in each method; the evaluation of water erosion in each 1 ha square cells, in which the area was divided; the classification of the evaluation results; the estimation of the affected areas according to erosion degrees; and the cartographic representation of erosive processes distribution.

The results show the usefulness of a methodology that combines the use of erosion models with Geographic Information Systems because it allows: to study the time variations in the erosions model; to analyze and keep up to date the large amounts of required information; to establish a standard methodology; to obtain graphic representations; and to serve as starting point for hydrologic and planning studies. Furthermore, the results show that 14,5 % of the "Comunidad de Madrid" area has a moderate to high erosion risk according to the CORINE methodology, while we obtain that 30 % of the area is affected by soil losses beyond 10 $t \cdot ha^{-1} yr^{-1}$ according to the USLE method.

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Tf. 34-1-3365686. Fax 34-1-5434879 / 34-1-3365866

NEW PUBLICATION

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