NEWSLETTER 3+4/2000

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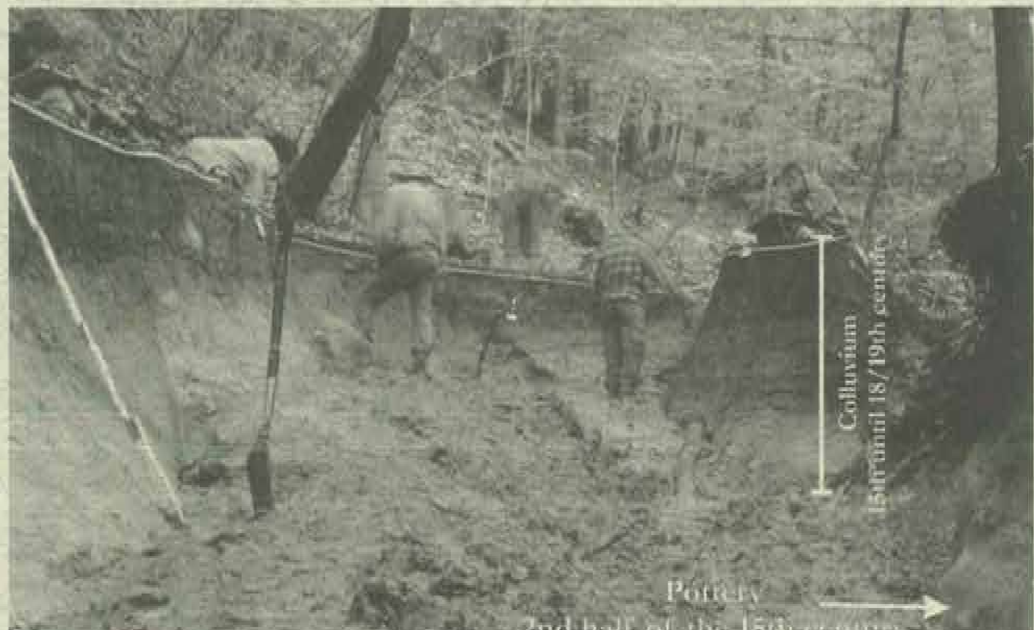

Evidence of historical erosion in the gully head at Wolfsgraben

E.S.S.C. NEWSLETTER 3+4/2000

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RECONSTRUCTING HOLOCENE LANDFORM CHANGE THROUGH SOIL EROSION IN EUROPE

Second Workshop of the ESSC Task Force on Long-term effects of land use on soil erosion in an historical perspective, University of Bonn, 29-31 October 1999

Members of the Task Force presented fourteen papers and seven posters. A field trip included a visit to an experimental station and to soil profiles in the vicinity of Bonn. In the final session, an integrated European research project was initiated on "Long-term soil erosion and soil conservation along the European ring".

The project comprises initially the setting-up of the following Working Groups:

Group	Topic	Chair
1	Definition of our language	Richard Dikau
2	Identification of key catenas and catchments	Claus Dalchow
3	Process-based description of profiles	Markus Dotterweich
4	Effects of single rainstorms in sediments	Leszek Starkel
5	Dating	Andreas Lang
6	Process-based definition of stratigraphy	Andrey Panin
7	Quantification of soil erosion and deposition	Hans-Rudolf Bork
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9	Past changes: natural or man-induced?	Leszek Starkel
10	Water circulation in catchments	Leszek Starkel
11	Scales and regionalisation	Valentin Golosov
12	Modelling of rainstorm events	David Favis-Mortlock
13	Definition of scenarios	John Boardman
14	Transfer of results to practice	Benediktas Kankauskas
15	Data management	Jürgen Wunderlich
16	Analysis of funding options	Richard Dikau
17	Relation to other research activities	John Boardman

Future activities of the Task Force:

November 1999 - June 2000: Working Group activities

September 2000: Third Task Force Meeting, Oxford UK - Agreement on standardisation of methods

September 2000 - October 2001: Preparation of European research proposal

September 2001: Fourth Task Force Meeting, Kraków, Poland - Finalisation of research proposal

December 2001: Submission of proposal to European Union

September 2002: Fifth Task Force Meeting, Moscow, Russia

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ABSTRACTS OF PAPERS

Water erosion as a consequence of tillage erosion in the hilly relief of Lithuania

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The hilly areas of Lithuania were formed in the early Holocene after melting of the last ice cover. The erodible glacial moraine and the abundance and intensity of precipitation creates a favourable environment for erosion of the parent rock by water. Although agricultural activity dates back to the end of the New Stone Age some 4,000-5,000 years ago, intense husbandry and the danger of soil erosion began only about 800 years ago. We have observed the importance of tillage as a mechanism of soil translocation on the hilly relief. Experiments on slopes from 3° to 15° show that a single passage of a mouldboard plough can transfer downslope some 1.0 to 7.2 t/ha when ploughing along the slope and 11.2 to 16.8 t/ha when ploughing across the slope. Data from twelve years of field experiments at the Kaltinenai Research Station give mean annual soil loss rates under crop rotations of 12.6, 31.6 and 44.9 t/ha on slopes of 2-5°, 5-10° and 10-14° respectively. Soil losses under different crops are: 5.4-29.6 t/ha with winter rye, 18.0-59.7 t/ha with spring barley, 44.4-196.2 t/ha for potatoes and zero for perennial grass stands. Tillage erosion is the most important cause of accelerated soil erosion. The thickness of soil deposits near the footslopes must be evaluated as an historical result of the combined action of tillage and water erosion.

Holocene erosion: research methods and some case studies from the East European Plain

A. Panin

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The front of cultivation of the land in European Russia has been moving southwards from the central regions since the 16th and 17th centuries. Human impact on the landscape is therefore rather sudden and young, providing an opportunity to study erosion at the transition between natural and anthropogenic conditions. The erosional history of the Holocene in European Russia was evaluated from the characteristics of sediment found in small valleys (*balka*) with catchment areas up to 100 km^2. The composition of the sediment was studied in the field by boring and by examination of natural exposures. In combination with detailed topographic survey, the evolution of the sediment profile was reconstructed. The chronology was established by ^{14}C dating; recent sedimentation rates were studied by ^{137}Cs method. Data were obtained for three key valleys: Berestovaya, Kramskoy Log and Yazvitsy. Each of the valleys demonstrates individual behaviour but some common features may be seen: (1) incision in the Late Glacial and domination of sediment accumulation over erosion during the Holocene; (2) the Holocene episodes of sedimentation correspond to events of slope instability caused by degradation of the vegetation cover - they may be either climatic in origin (as at the end of the Late Glacial or early Holocene) or induced by catastrophic events such as fires (throughout the whole Holocene); (3) active bottom erosion is characteristic of the second half of the Holocene (Sub-Boreal and Sub-Atlantic periods); and (4) anthropogenic impact disturbs the stability of the valley floor or strengthens the tendencies of gully growth and acceleration of sediment accumulation, but seems unable to turn them back.

Land degradation over the last two centuries in the Moldavian Plateau

Ion Ioniță

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Long-term field surveys of erosion features using sequential aerial photograph interpretation and classical levelling work on gullies provide the basis for classifying the major stages of land degradation in the Moldavian Plateau over the last two centuries. Economic growth with significant environmental impacts dates from 1829 when the Turkish monopoly over Romanian trade and navigation along the Danube ceased at the end of the Russian-Turkish war. Since that time, five stages of land degradation can be identified. (1) The preparation stage (1829-1899) was associated with the most dynamic changes in the natural landscape as evidenced by a sharp increase in cultivated land (6% to 36%) and the loss of forest (47% to 22%). However, it is dangerous to associate deforestation at this time with soil erosion since the prevailing farming system consisted of alternating cropped fields with fallow; only one-third to one-half of the total arable land was cultivated every year. (2) The transitory stage (1990-1920) was marked by the extension of cultivated land to over 50% of the area and the decline of fallow practices in favour of up-and-downslope farming. (3) The climax stage (1921-1970) followed a new land reform that involved splitting of the land holdings. There was no significant change in land use but the continued up-and-downslope cultivation on small plots allowed sheet erosion, gullying and landslides to flourish. The peak rate of land degradation occurred in the 1960s. (4) The decreasing stage (1971-1990) was associated with changes in rainfall pattern and the take-up of contour farming and other conservation practices. (5) The revival stage (since 1991) is due to Land Property Law No. 18 which again encourages up-and-downslope farming on small plots.

Holocene valley floor transformation as a result of soil erosion in the drainage area, San river valley, Eastern Carpathians foreland, S.E.Poland

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[**] Earth Sciences Institute, M Curie-Skłodowska University, Lublin

The San river valley drains a mid-mountain area of 3,600 km^2. The Holocene alluvium within the mountains usually infills the narrow valley floors, whereas in the foreland it builds up a broad alluvial plain capping older Pleistocene/Holocene alluvia. Two generations of palaeomeanders are visible under the level deposits on its margins. The structure and age of one of these channels, with an infill up to 7 m deep, provides information on the rate of infilling, related to climatic change and human activity. The lower complex is represented by a clayey-silty unit, up to 2 m thick, with organic lamination, capped with a dark-brown peat up to 2 m thick with mineral intercalations representing an abandoned channel environment. The lowermost organic intercalation of silt is dated to 15,000 ± 500 years BP, the basal part of the peat complex to 9,000 ± 120 years BP and its top to 6,900 ± 100 years BP. The upper complex is represented by silts, grading into typically massive grey clays. The interruption of peat accretion reflects the progressive increase of overbank discharges of the San and sedimentation. A characteristic feature of the silts is a high content (23-25%) of 0.005-0.02 mm sized particles, typical of the Carpathian loess cover. These are evidence of intensive erosion caused by significant deforestation and agricultural colonisation. In the mid-mountain part of the San Basin, human activity, presumably by the pastoral tribes of the Cord Ware culture, started at the end of the Atlantic period. In the fourth millennium BC the Neolithic farmers of the Funnel Beaker culture colonised the area and for over 2,000 years (6400 to 3700 BP) used environmentally repressive farming. This undoubtedly caused the soil erosion and increasing flood amplitudes in the Carpathian foreland. The intensive overbank sedimentation caused the levee construction and palaeochannel fossilisation.

Evaluation of sediment redistribution during period of intensive cultivation within river basins of steppe and forest-steppe zones, Russian Plain: general approach

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Intensive cultivation of the steppe and forest-steppe zones of the Russian Plain began some 200-250 years ago. The area under cultivation increased from 5-10% to 50-65% in only 30-50 years. As a result, soil erosion and gullying increased dramatically and river aggradation occurred throughout the region. An approach is developed to evaluate the redistribution of sediment and the mechanisms involved following the intensification of agriculture. The temporal dynamics of aggradation were estimated from measurements of stream lengths on topographical maps of different periods. Information was obtained about crop rotation, changes in cultivation, and soils and climatic conditions. Soil-morphological methods, radionuclide methods and empirical erosion models are used to estimate soil losses for cultivated fields; volumes of ephemeral and bank gullies are measured directly in the field. The age of gullies is established by comparing topographical maps and aerial photography of different dates. The volume of sediment in valley bottoms is defined from drilling or digging pits. The ^{137}Cs technique was used to evaluate the sedimentation rate since 1954. The area of deposition was measured by tacheometric surveys. Sediment delivery for study catchments was established by comparing calculated soil losses and sedimentation volumes. The approaches used were able to explain the sediment redistribution observed in both large and small catchments.

Pedological studies of environmental changes in prehistoric times at Western Lake Constance and surrounding areas

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The connection between archaeology and pedology and the interpretation of environmental change is illustrated with reference to soil profiles in three different relief positions representing areas of erosion, areas of accumulation and stable areas. Areas of erosion have a high density of archaeological findings. The intensification of agriculture over the last 30 years has caused enormous amounts of erosion, exhuming archaeological evidence. In an excavation north of Singen, findings range from middle-neolithic ceramics to a system of ditches of late Latène time (4800 BC to first century AD). The ditches are considered as part of a 'Viereckschanze'. Depending on the relief, the ditch lies at different depths. In the south of the site, the ditch is at 1 m depth and covered and sealed by colluvial deposits, eroded and transported from higher ground. During or after late Latène time, huge levelling processes began in the

landscape, leading to Pararendzina, luvisols and colluvial deposits forming side-by-side. An example of a stable site is found on a plateau with gentle slopes near Bernrain, in Thurgau Canton. Here 10-cm diameter post holes occur only 30 cm below the surface and ceramics can be picked up in the humic layer at the soil surface. Since a complete Parabraunerde profile (luvisol) remains at the site, it is sure that the humic layer is identical with the late Bronze Age soil surface and that no later erosion or accumulation has taken place. Accumulation sites occur on the lower parts of slopes and in depressions. In the Uerschhausen at Lake Nussbaumen the colluvial deposits sometimes reach a thickness of 1 to 1.5 m, covering a luvisol with relict marks of groundwater influence. Sedimentation began during late Neolithic (3020-2780 BC from carbon dating) with significant deposition during the early Bronze Age. A stable period with little sedimentation occurred in middle to late Bronze Age, ending with a rise in sedimentation in Hallstatt and Latène times. After the Roman period there was less sedimentation up to the late mediaeval, when the rate rose steeply again.

Signs of Late Holocene erosion in the soil cover of the Trojan plateau

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Previous investigations of intensive soil erosion in the Mediterranean have been conducted on alluvial and colluvial sediments which reflect the chronology and intensity of deposition of eroded material from more or less large catchments. Such studies give little insight to the spatial distribution of erosion within the catchment which, in many cases, is of significant archaeological and palaeoenvironmental concern. This study uses an analysis of the distribution of surface soils on slopes in the Trojan plateau to infer patterns of soil erosion in the past. The soil cover was examined at some 100 sites which were described with respect to morphology and classified into groups with more or less developed profiles; the approximate duration of soil development was estimated from archaeological evidence and radiocarbon dating. The results show the presence of relatively young soils and soil burials on the Low Plateau near the site of Troy with older soils further away; this distribution can be explained by intensive anthropogenic soil erosion in the Bronze Age and the Byzantine period close to the site. The reconstruction assumes that the zone of intensive agricultural use was a segment of a circle centred on Troy and with a radius of 1.5-2.0 km. Soil erosion on the eastern part of the Low Plateau and on the High Plateau occurred on a rather limited scale, if it took place at all. The interpretation is preliminary and needs to be verified and refined on the basis of many more soil profiles.

Landform changes through soil erosion in Franken, Bavaria, Germany

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The Wolfsgraben is one of many ravines cut into the silty-sandy material of the Triassic benchlands on the western side of the Upper Main valley. The ravine and its alluvial fan were analysed in 14 exposures and 30 drillings to reconstruct soil formation, extreme rainfall events and landuse changes in historical times. Detailed field studies, chemical soil analysis, radiocarbon dating and dating of pottery were used alongside written documents to unravel a complex stratigraphy involving more than 50 phases of landscape development in mediaeval and modern times. Before the first landuse, the postglacial shape of the Wolfsgraben was formed by periglacial processes and then protected by natural vegetation. In the 14th or early 15th century, intensive landuse and extreme rainfall resulted in a deep gully which was later filled with material from small landslips and colluvium. In the 15th and 16th centuries, landuse was at a low intensity. Between 1618 and 1648, the German Thirty Years War reduced population to a minimum and the pressure on land was very low. After that time and in early modern times, the slopes were used as vineyards and hop gardens; soil was eroded from the slopes to an average depth of 70 mm and colluvial sediments accumulated in the valley bottom with a thickness of 5 m. Towards the end of the 19th century, a second major erosion event produced a 2 m deep and 400 m long gully. At the beginning of the 20th century the fields were slowly abandoned and after the Second World War, forest developed. Between 1350 and 1750 AD, the total sheet erosion was nearly 70 mm (0.17 mm/y) and the linear erosion caused by a single extreme event some time between 1751 and 1900 was approximately 1600 mm. The study shows that landforms have changed dramatically in historical times through intense landuse combined with heavy rainfall events. As a result of soil erosion, the soil fertility has declined and today the soil is poor; on many sites there is only the C-horizon (source rock) at the surface.

Sediment budget of a small watershed in the Pleiser Hügelland near Bonn and its significance for landscape development

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With a digital elevation model and a soils map at 1:5000 scale, a sediment budget was calculated for a small drainage basin in the Pleiser Hügelland, near Bonn. The soil polygons on the soils map are the calculation units for the analysis. Considering two scenarios for the initial soil depth of climax loess soils, soil erosion and accumulation volumes were calculated for each soil unit. For both scenarios, the sediment delivery ratio (SDR) based on the soils map is higher than expected for a drainage basin of only 14 ha. Values of SDR for the whole catchment range from a maximum value of 88% for both scenarios to minimum values of 60% and 47%; the mean value is 77%. These results contrast with those obtained using data derived from empirical examinations of soil profiles. If the accumulation depths of slope colluvium are calculated for each soil unit and integrated across the whole catchment, the SDR is 30% for both scenarios. This discrepancy in results stresses the importance of sediment sinks in the landscape. Even for a small drainage basin with relatively little storage capacity, sedimentation represents a significant factor. It is therefore important, especially in small basins, to calibrate the soils map with data from the study area since the results depend on specific local conditions. The explanation of landscape development cannot be derived solely from a soils map. A holistic assessment of the landscape system is needed. The quantification aspects of such an assessment are best dealt with by the sediment budget approach.

Reconstructing soil erosion using OSL-dating techniques in the basin of Phlious, N.E.Peloponnese, Greece

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[**] Geographisches Institut, Universität Bonn

Strong agricultural use of the land in the N.E.Peloponnese began in Neolithic times and archaeological finds of the Early Bronze Age lead one to suppose the area was intensively cultivated by people with a complex administration. To study Holocene soil erosion and its impact on the landscape, the Phlious basin with its known early settlements is investigated. The stratigraphic record of colluvial and alluvial sediments is used for reconstructing the former landscapes. Altogether, 19 boreholes were drilled and 5 pits were dug along a 2 km transect. Optically stimulated luminescence dating (OSL) was used to establish the chronology of the sediments. First results of the investigation show strong hints of soil erosion. Today the slopes in the basin bear no soil at all whereas colluvium up to 8 m deep with many sherds is found on the footslopes. Drillings from the centre of the basin show Pleistocene lake deposits to a depth of 5 m. Based on OSL-ages a mean aggradation rate of 1.5 mm/y is calculated for the last 1,000 years. This rate closely matches the uplift rates of 1-2 mm/y determined for the Gulf of Corinth region.

Landscape development and landuse changes in the Pacific Northwest (USA)

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During two field trips in 1997 and 1998 members of staff and students of the University of Potsdam, Washington State University at Pullman and the Technical University of Braunschweig reconstructed landuse history and landscape development for the period of European settlement in the Pacific Northwest. The first European settlers came into the region around 1850. The early farmers made clear cuts in the forest to establish small fields, gardens and fenced meadows for the subsistence of the families. Between 1850 and 1900, the biggest part of the country was transformed into open rangeland where local farmers could keep their cattle together. At this time, the farming system worked more or less without bad ecological effects because the farmers kept a permanent vegetation cover. From 1901 to 1930, grain crops became the dominant agricultural commodity. Large fields were established and big horse- or steam-powered machines were used. Water erosion became a common problem as shown by the analysis and dating of colluvial sediments. The early 1930s were the worst years for European farmers in the Pacific Northwest. Due to severe erosion damage, some very dry years and the reduction of market prices, farmers began to leave. Most of the fields were turned into pastures and taken over by cattle breeders who continued to extend their farms. Agriculture was intensified by the help of tractors and fertilizers and extended on to steep slopes. With the use of pesticides, crop rotation was no longer common and erosion rates increased steadily to among the highest in the world. Between 1930 and 1971, farmers in the Palouse region lost more than 20% of their organic top soils. Between 1971 and 1998, there was a migration of people to urban areas. Vast areas in the east of the region are almost depopulated; remains of ghost towns can be found all over the Columbia Basin. Most grain farmers on the better lands have started to apply soil conservation. As a result, average erosion rates have declined though the problem is not yet solved.

La Tène age soil erosion and landuse in Southern Germany by the example of a Celtic square enclosure: the Viereckschanze of Poign, Lkr. Regensburg

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With the help of pedological, morphological and archaeological methods, an attempt is made to reconstruct the landscape and its development in the Regensburg area as a basis for a landuse model of the late La Tène age and the early Provincial Roman period. The area is situated in the Altsiedelland which has a history of settlement dating back to the Palaeolithic era. The study is focused on two Celtic square enclosures: the Viereckshanze of Poign and the Viereckschanze of Moosfeld, and on the Roman villa of rustica Moosaecker. Two phases of landuse are documented: deforestation and intensive agricultural use in Celtic times, as represented by the erosion of the Holocene luvisol; and the end of Celtic agriculture (709-977 AD), as represented by colluvial accumulation. In several of the valley floors, depositional sequences of peat and colluvium are found. Dating the peat enables the periods of land clearance and farming to be determined. The sequence indicates the landuse changes that have occurred since Neolithic times, through the late Bronze Age, early Iron Age, late Iron Age (La Tène) and the Provincial Roman period, culminating in an expansion of landuse in late Mediaeval time, not allowing the peat bogs to recover.

Identifying colluvial bodies from the surface: a test case using 2-D-geoelectric surveys on a loess-covered slope near Bonn, Germany

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Based on previous investigations a colluvium (Talkolluvium after Bork, 1988) was presumed to exist on a loess-covered slope at the Frankenforst Research Farm in the Pleiser Hügelland near Bonn, Germany and later confirmed by studies of three catenas. Because of the non-uniform distribution of colluvial and eroded soil horizons, the existence of a filled gully at right-angles to the main Forstback stream was inferred. On the assumption that the material properties of the eroded soil, naturally formed soil and colluvial fill differ significantly, a 92 m long 2-D-geoelectrical profile with 24 electrodes parallel to the slope was deployed to locate the gully. A section of higher resistivity could be found indicating the location of the gully fill. To confirm these geophysical investigations, ten drillings were made on the same profile. The results fit the geophysical data reasonably well. Therefore 2-D-geoelectrical surveys seem to be feasible for the identification of subsurface features caused by soil erosion.

Landform changes since 1700 AD through soil erosion in Brandenburg, Germany

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Some 50 km east of Berlin and 2 km west of Wriezen is a complex glacial and periglacial ravine system cut into the edge of a plateau of ground moraine where it slopes down to the alluvial plain of the Oderbruch. Since 1998 the authors have investigated two gully systems to determine their age, the processes and causes of gullying and infilling and the overall erosion balance. The southern section of the area is characterised by a gully system originating from prehistoric times. The stratigraphy of the sediments, based on sedimentological and pedological evidence, ^{14}C and thermoluminiscence dating of charcoal and ceramics shows 26 phases. The northern part is characterised by a gully system developed over the last 50 years. Dendrochronological methods applied to living black locust trees on the alluvial fan show stress symptoms in 1962, 1972, 1978 and 1987. Analyses of ^{137}Cs isotope concentrations in the colluvium and soil formations on the fan show the peak associated with the Chernobyl acccident in 1987 in a humic horizon some 40-50 cm below today's surface. From this information and an analysis of precipitation data of the last 30 years, four phases of accumulation, burying the trees on the colluvial fan, can be identified. The mass balance for the local erosion shows an alluvial fan of 1250 m^3 of which 930 m^3 relate to the volume of the gully and 320 m^3 to erosion of sediment in the catchment area, transported through the gully and deposited. The study shows that soil erosion caused by heavy rainfall and intensive landuse has changed landforms dramatically in historical and modern times.

The scale problem in soil erosion research: long-term soil transport through catchments

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The processes of soil erosion (detachment, transport and deposition of soil particles) have been observed and analysed mainly on agriculturally-used slopes, often using small erosion plots. No method exists that allows the exact measurement of the processes along slopes and through valleys; therefore, little is known about the transport of eroded particles through small and large catchments. Detailed soil and sediment profile analysis was used to reconstruct the transport of soil particles through catchments of different sizes in mediaeval and modern times. More than 3000 profiles have been investigated in Germany. Maximum erosion rates relate to agriculturally-used slopes in the first half of the 14th century and the 18th century. Some 60-100% of the eroded material was deposited as colluvium immediately downslope and in the transition area between the slope and the neighbouring valley bottom. Only a small amount was transported in floods in larger valleys dependant upon the grain size of the sediment and the local characteristics of the topography, vegetation and the valley floor. In the hilly Young Moraine landscapes of northeast Germany, sandy soil horizons dominate the soil surfaces and the flow velocities in the flat valley floors are insufficient to transport sand, even during heavy rainfall and runoff events. In some catchments not a single grain of the material eroded on the hillslopes has been deposited in large floodplains in the past 8 to 12 centuries. In contrast, on the loess-covered basins and plains, clays and fine silts have been transported to the valley floors as suspended load from the hillslopes through the river systems. Only some 75-90% of the eroded material is deposited during the first several hundred metres of transport distance. Alluvial layers built from clayey, silty and loamy suspended sediment load have been deposited in the floodplains of larger (second order and higher) catchments. In the 14th and 18th centuries, sediment transport was sometimes different in the loess landscapes. Extreme rainfalls with recurrence intervals of 200 and 1000 years eroded and transported loamy aggregates which, because of their weight, were quickly deposited as colluvial layers in the thalwegs and first order valley floors as fan sediments; only a few particles reached the large floodplains.

Peculiarities of observations on long-term processes of soil erosion in agro-landscapes with an introduced system of soil control agriculture

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In recent years, a system of soil erosion control has been introduced in the steppe zone of the Ukraine, based on contouring. The hypothesis is established that every element of the system, e.g. shelterbelts, structures and types of land use, represents a check point for the transport of sediment over the landscape for the years since it was put in place. Investigations have been made by use of biotraps, markers and phytoindicators. Thus shelterbelts form a system of biotraps promoting sedimentation before wind removes material from fields; every windbreak has its own dust collecting area. Extraction of dust from the tree litter gives information on soil loss from deflation of agricultural lands for a 2-5 year period. The investigations show that tree planting decreases deflation. Over the last three years, annual soil loss by deflation from agricultural lands has not exceeded 100 kg/ha; the loss is 54 kg/ha from ploughed land, 40 kg/ha from tilled crops, 32 kg/ha from winter crops, and 10 kg/ha from perennial grass. A small field watershed divided by contour banks into a cascading sequence of microwatersheds was chosen for the study of erosion from snow melt and rainwater. The watershed area is 2.13 ha of which 0.072 ha is under the banks and 0.098 ha under windbreaks. The landuse is gramineous grass, sown in 1991. The average steepness of the thalweg is 4° and of the sideslopes is 3-7°. The method of phytoindication was used to determine soil loss or sedimentation; this consists of arranging check profiles across the watershed where excavations are made of the upper layer of soil to the depth of tillering of the grasses in not less than 10 points. By comparing the difference between the depth of tillering at these points with that at control points on the watershed divide, the level of outwash or sedimentation is obtained. For the determination of the quantity of sediment in the windbreak and behind the ditches, the method of markers was used. The windbreak was established in 1988 and for the next three years there was soil cultivation between the tree rows. In the following years, sedimentation occurred where the windbreak crossed the watershed thalweg. The cultivated soil differs from the overlying sediments in its structure and can therefore be used as a marker. For the sediments in the ditches, the marker used was a layer of straw mulch placed on the bottom on the ditches in 1991. The results of the study show an alternating pattern of erosion and deposition down the slope. The soil loss for the whole watershed over eight years is 25.82 t giving a mean annual erosion rate of 1.51 t/ha.

Soil erosion and environmental change. Research within the Priority Programme on "Changes of the geo-biosphere during the last 15,000 years"

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In 1994 the Deutsche Forschungsgemeinschaft launched the priority programme on "Changes of the geo-biosphere during the last 15,000 years. Continental sediments as evidence for changing environmental conditions". The programme is a contribution to the IGBP core project PAGES. The goals of the programme are to deduce changes in the geo-biosphere from natural archives and, if possible, to relate them to archaeological findings. Investigations concentrate on three clearly defined time slices: (1) the transition from the last glacial period to post-glacial times; (2) the post-glacial climatic optimum; and (3) the period from ca 1500 BC to 500 AD. Projects dealing with soil erosion focus on the last two slices in which landuse and the intensive use of natural resources by man increased. The study areas are located in different regions throughout Germany covering the natural archives of fluvial sediments, colluvial deposits and soils, fens and bogs, laminated lake sediments, and coastal sediments along the Frisian coast and the Baltic Sea. About 15 research groups of the priority programme focus on investigating the magnitude and possible causes of soil erosion. An example, presented in this paper, is the work carried out by the author and W.Andres, on the loess-covered Amöneburger Becken in the Hessian Depression. The study site is at the edge of the Ohm floodplain where colluvial deposits interfinger with organic sediments. Organic material from colluvial layers and from corresponding organic layers was radiocarbon dated by conventional ^{14}C and AMS; based on the datings, they were related to cultural periods and changes in local vegetation which had been inferred from pollen, macro remains and mollusc analysis. The results indicate that during early Neolithic times the intensity of soil erosion was rather low. It increased at the end of the Neolithic period and was high during the Bronze Age, Iron Age, the Roman period and in mediaeval times. The resulting erosion on one hand and sediment accumulation on the other considerably smoothed the pre-existing relief. The results fit well with those of other research groups. The data resulting from all the work in the priority programme are stored in the information system PANGAEA at the Alfred Wegener Institute, Bremerhaven (URL: http://www.pangaea.de/).

The role of various landnam phases in the transformation of slopes and valley floors in Poland

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The reconstruction of the morphogenesis of landnam phases should be based on parallel studies of present-day processes and palaeographic ones. The first are carried out at experimental stations and help to determine the rates of various processes in relation to soils and landuse, especially during extreme events. The second involve archaeological, sedimentological, palaeobotanical studies accompanied by ^{14}C and other dating techniques. The most distinct evidence for soil erosion from early Neolithic times comes from studies at Pleszów, near Kraków, where, beneath the edge of a loess terrace, silty layers overlying peats show a simultaneous erosion response to the cultivation of cereals ca 6200 BP. Several other sites show evidence of the formation and infilling of late Neolithic gullies, coinciding with the shift from deposition of organic to mineral material in the flat valley bottoms. Several reactivated dunes document the deforestation occurring in the Neolithic and Bronze Age periods. A number of sites close to the Hallstadt settlement in Biskupin show the transformation of slopes of the morainic hills and kame terraces. The deforestation of the Roman time caused a rise in groundwater level in the young morainic landscape and deposition of sediment in the newly-formed shallow lakes. In the upper Vistula valley, tree stems were fossilised in the flood deposits and in the lower part of the valley peats were covered by alluvial loams. The deposition from the last millenium is recorded in various places where it coincides with rapid changes in the AP-NAP relationships; in Kraków town and surrounding loess areas, the effects of even single floods from the 11th century can be recognised in the deposits. Especially distinct is the rapid response to forest clearance and the foundation of new villages at the end of the 15th to early 16th century in the eastern part of the Polish Carpathians. The long term effect of these changes on slopes and valley floors is degradation in the upper and middle part of the hillslopes and deposition on the lower part, leading to downwearing of slopes, preservation of the convexo-concave profile and a tendancy to elongation downslope. Accelerated runoff in cultivated areas leads to the formation of gullies and deforestation to many shallow slides and reactivation of dunes. In small valleys, there is a general aggradation of the valley floor. In larger valleys, there is a rise in the level of the floodplain and a change in channel parameters related to the increase in discharge and sediment load; in many instances there is a tendency to braiding. In the earlier phases, the higher frequency of extreme events is superimposed on the accelerated runoff and erosion associated with changes in landuse. In most cases, however, it is difficult to distinguish between the role of climatic oscillations and human intervention.

Long-term rates of soil erosion. Is landuse change more important than climate change? A simulation modelling approach

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It is far from easy to disentangle the erosional effects of past shifts in land use and climate using field evidence. Existing records of erosion rates are rather short. For longer-term information we are almost always forced to work from knowledge only of the total thickness of material eroded; in many cases, even this is poorly known. But even if long time series rates of erosion were available, this would still leave the problem of separating the contribution of landuse change from climatic change. Climate and landuse rarely remain static long enough for rigorous statistical frequency-magnitude analysis. Shifts in landuse and climate may also be concurrent and possibly correlated such as where climatic improvement or deterioration result in the adoption of new crops. The issue is complicated still further by the temporally varying contribution from large rare rainfall events and small common events. The timing of high magnitude, low frequency events with respect to periods of agriculturally bare ground can contribute a strong stochastic component to records of past erosion. In the face of these difficulties, models can offer a way forward. This study uses a modified version of the EPIC (Erosion-Productivity Impact Calculator) model to evaluate the relative influence of climate, landuse and extreme rainfall events upon rates of soil loss for a site on the South Downs, UK, in the last 7000 years.

Modelling Late Holocene landform development through the processes of sediment redistribution

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Geomorphological approaches to landform evolution range from classical genetic models of morphological evolution to detailed models of process behaviour. Recent decades have seen an increasing divergence between the two approaches. A greater understanding of the link between process behaviour and landform genesis is required to address problems associated with modelling of landform evolution. Late Holocene landform evolution in the loess-covered hill country of middle Europe can be usefully characterised as a transfer of sediment through a series of storages of varying longevity. In small headwater basins, exchange of material between erosional and depositional units occurs principally through diffusive wash. There is the possibility of extending existing empirical and physically-based models of this process, e.g. EROSION3D, EUROSEM, to simulate landform change through erosion and deposition. But the models are demanding both in terms of data and computing resources; their application to wider areas and longer temporal scales is therefore problematic. A possible means of overcoming the obstacle to modelling presented by data requirements lies in focussing on the relationship between morphometry and the redistributive process. Using ^{137}Cs, a relationship between morphometry and rates of sediment redistribution over a period of 45 years can be developed. The viability of backward extrapolation of this relationship can be tested by comparison of modelled palaeosurfaces with dated stratigraphic surfaces. This research approach questions whether the form-process-form relationship is amenable to modelling. While assumptions relating to the behaviour of headwater basins are reasonable, they are also somewhat limiting. They are violated in larger areas where processes other than diffuse erosion occur. Another approach is therefore required for modelling landform evolution in areas other than headwater basins. The key to such an approach may lie in consideration of the system that is to be modelled. A cascading system represents the link between process-response sub-systems of the morphological evolutionary system. Rather than focussing on the component sub-systems, landform evolution may be more readily modelled as a cascading system of sediment redistribution. The sediment cascade is a system of linked sediment storage units. The temporal development of each unit can be represented as a plot of sediment accumulation against time. Linking these units in a spatial context enables identification of patterns of sediment redistribution and may further enable some means of empirical modelling and, ultimately, explanation.

Environmental history of the Trier area: natural and man-made factors influencing landscape history

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The work described falls in the framework of the interdisciplinary research project, "Environment and region", which covers 16 scientific projects within the University of Trier from across geosciences, social sciences, economics and psychology, supported by the Deutsche Forschungsgemeinschaft. With the beginning of the Neolithic period, man started to interfere with the environment, particularly through agriculture, causing an increase in erosion rates. The current state of knowledge points to peripherally organised settlements in the Trier area during the Bronze Age. By the beginning of the Roman Conquest, the newly-founded settlement of Trier became the centre of economic and social life of the region. Vineyards were cultivated on the slopes of the Mosel valley and its tributaries. Landuse changed drastically from extensive crop growing and animal herding to large-scale agricultural production on intensively cultivated farmland, causing lasting changes in the balance of the ecological system with effects on soil forming and soil erosion processes. The Middle Ages were characterised by increasing population pressure which resulted in the settlement of the Eifel and Hunsrück mountains, accompanied by widespread clearance of woodland. The resulting increase in soil erosion is still visible today as incised gullies on hillslopes and fans on the valley floors. Adverse weather conditions, especially in the Late Middle Ages, also favoured erosion. In respect to today's discussion on the possible causes and effects of global climatic change and the *Waldsterben* on actual and future water budgets and on soil erosion, knowledge of the mediaeval environment can help to assess future impacts. The Modern Times are characterised by developing industrialisation and increasing traffic, as well as increasing mechanisation in farming. It is supposed that the human impact on the environment in this period has only been exceeded by the woodland clearances of the Roman period and the Middle Ages. Therefore, recording the dynamics of these periods creates a valuable basis for developing future environmental management strategies.

SOIL CONSERVATION IN SLOVENIA

Introduction

The important aim of development policy today is the preservation of the natural resource of soil from physical destruction and pollution, as well as the preservation of the balance between the soil and other parts of the ecosystem. Today, over 50% of Slovenian territory is covered by forests; they protect the slopes and valleys from erosion and mass wasting. But in the last 20 years, the fertile land and forests have been substantially damaged. The reasons for that lie in intensive industrialization and agricultural production combined with dense traffic and urbanization. Intensive agriculture often causes excessive burdening of soil with nutrients (e.g. nitrates and, to a lesser degree, phosphates) and plant protection agents (pesticides). The use of heavy machinery contributes to the physical degradation of soil. Table 1 defines the types of soil degradation and consequences. Use of the environment can have one or more consequences in the soil. The type of soil gives rise to different tolerances to the exploitation and land use.

Table 1. Types of soil degradation and their consequences (after http://www.sigov.si/mop/menu.htm)

Types of soil degradation	Consequences
physical	erosion
	soil compaction
	structure destruction
	surface crust
chemical	runoff
	acidification
	salinisation
biological	decrease of organic substance
	reduced biotic activity

Slovenia belongs to those countries in transition in which the impact of the former socialist economy on the environment is less distinctive. Nevertheless, rapid industrialization and urbanization disregarding the environment, particularly in the first decades following the second World War, have resulted in the degradation of practically all environmental components.

Results

Soil erosion

Wind erosion in Slovenia is a less noticeable phenomenon. However, in the Vipava valley, all the conditions are fulfilled for the development of wind erosion which occasionally takes a very bad form. The most pronounced form was noticed in the year after extensive drainage works, as many hedges were eliminated and many ploughed-up pieces of land left bare over the winter.

Water erosion in Slovenia shows a slight decrease, at least that which is caused by arable agricultural land. Many a vineyard is covered with grass and is not hoed any more. However, new erosion spots can appear very quickly because of unallowable clearings and lack of woodland road maintenance or even due to technically improperly executed earth works for pastures and vineyards.

Acidification of soils

In a large part of Slovenia, soils are developed on the bases containing a lot of Ca and Mg cations. The buffering capacity of such soils is large, therefore no essential changes in the pH value are expected. The soil on noncarbonate (silicate) bases is more strongly exposed to acidification. The same can be maintained for the washed out soils on deep decalcified depositions. Woodland soils are more heavily exposed to the process of acidification since they are usually more acid than agricultural (arable) soils. Forest trees also better retain deposits from the air because they have larger leaf surface areas than agricultural cultures. There is a danger of lowering the pH-value of the soil in intensive agriculture, where only mineral fertilizers, especially acid mineral fertilizers, without regular soil fertility control, are used.

Soil pollution

A system for the monitoring of soil pollution has not yet been set up. We have only the examples of the case-study of soil pollution research around industrial buildings, the examples of case-studies of soil pollution in the environs of motorways and soil pollution as a consequence of agricultural activities. Analysis of soil pollution around industrial buildings showed that the content of mercury, chrome, nickel, copper was conspicuous. Arsenic, chrome and cobalt reach higher values at point near factory emissions.

Intensive processing of food can also have adverse affects on the environment and the soil–plant–underground water system, contributing to agricultural pollution. According to the classification of problems, soil pollution takes the 1st place; pesticides in the environment 5th; air pollution from thermal power plants (also affects soil and forests) 6th; traffic (also affects soil) 9th; forest damage 12th; loss of biological and genetic diversity 21st; degradation of agricultural and forest soils 26th; and soil erosion 36th place respectively (http://nfp-si-eionet.eu/soe/soil.htm).

The sources of emissions in the soil are industrial emissions, heating boilers, waste water treatment plant sludge, wild landfills, mineral fertilizers, phytopharmaceutical products, substances in irrigation water and emissions from traffic.

Conclusions

In Slovenia there are some regions where the soils are heavily polluted. In the past the main polluters were metallurgic, chemical and industrial processing plants, causing industrial pollution. The dense population in some parts of the country and strong daily migration to the place of work contribute a lot to soil and urban pollution. The intensive foodstuff production can also have negative effects on the environment and on the soil–plant–groundwater system, which is called agricultural pollution. The intensity at which basins and valleys are engulfed in fog, windy positions and bedrocks rich in some heavy metals can all increase or decrease the man-made pollution. The objective of soil management is to ensure the balance between the conservation of the natural properties of soil and the provision of a satisfactory quality of life for human beings.

The conservation and protection of soil in Slovenia is based on limiting:

- chemical soil pollution (acidification, run-off of Ca and Mg-cations and of clay minerals)
- physical degradation of soil (compaction, erosion, structure destruction etc.)
- other degradation of soil (biological as resulting from reduced of biotic activity and destruction of soil properties through man).

In Slovenia there are some areas where the soils are heavily polluted:

a) agricultural pollution areas: intensive foodstuff production has negative effects on the environment and on the soil–plant–groundwater system: Drava and Mura valleys, Savinja valley near Celje, Sava valley and vineyard areas;

b) urban pollution areas: dense population of some parts of the country and strong daily migration to the place of work contribute a lot to the soil pollution: Ljubljana, Maribor, Celje, Kranj and Koper regions;

c) man-made pollution areas: the "anthropogenic" intensity in basins and valleys engulfed in fog, effects on ground- and running water and soil properties: Celje basins, Ljubljana basins, Sava and Drava valleys.

In accordance with the Strategy for Economic Development of Slovenia, in the forthcoming medium term the expenditure of budget funds for environmental purposes, including environmental protection investments, should amount to 1.5% of GDP. It is estimated that in recent years the share of public funds allocated to environmental protection projects has been less than 0.5% of GDP.

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NEW PUBLICATIONS

Medvedev, V.V. (ed), 1999. ***Collection of papers by Ukrainian members of ESSC.*** **Institute for Soil Science and Agrochemistry Research, Kharkiv, Ukraine, 75pp.**

Contents:

Conservation tillage in the Ukraine (V.V.Medvedev)

Classification and mapping of the soil degradation (T.N.Laktionova and V.V.Medvedev)

Study of soil erodibility parameters of mollisols (S.Yu.Bulygin, A.B.Achasov, M.M.Kotova and A.M.Vereshaka)

Long-term processes of soil erosion in agrolandscapes (V.I.Tarasov)

Wind erosion of soils in the Ukraine (D.O.Timchenko)

The algorithm of mapping and monitoring of chernozems on the ground of the surface soil: soil researches and SPOT (A.V.Shatokhin)

Supply of nitrogen in agricultural crops in conditions of polyelement pollution of soil by the heavy metals (A.I.Fateev and V.L.Samokhvalova)

Contamination of Ukrainian soils by heavy metals: aspects of computer cartography (V.I.Kysil, O.Mirenskaya and A.F.Savenkov)

Change of carbon and nitrogen content in chernozem typical at different systems of fertilization (N.V.Livosoy, V.P.Filatov and O.F.Revenko)

On a problem of soil impoverishment by the phosphorus combinations accessible to plants (A.A.Khristenko)

The efficiency of soil mulching in the left-bank forest-steppe of the Ukraine (T.E.Lyndina)

The influence of organic substances on the soil humus status (E.V.Skrylnic)

Publication obtainable from: Institute for Soil Science and Agrochemistry Research, Chaikovskogo str., 4, Kharkiv, Ukraine 61024.
Tel. 380 (572) 470-531
Fax. 380 (572) 194-098
e-mail: arsi@skynet.kharkov.com

FORTHCOMING MEETINGS

3-5 January 2001
Soil erosion research for the 21st century
Honolulu, Hawaii

The conference has a variety of sessions that will provide an opportunity for participants to share knowledge and ideas. There will be three keynote speakers on wind erosion modelling and control, water erosion modelling and control, and soil erosion quantification techniques. Panel sessions will facilitate discussion of erosion research in small groups. Individual lecture and poster presentations will provide information on current erosion research efforts. A half-day mid-meeting tour and an optional post-meeting tour will allow participants to view erosion and sedimentation problems and solutions at first-hand under tropical conditions.

Meeting organised by the American Society for Agricultural Engineers

Registration:

Early Bird (by November 16, 2000) - ASAE member $289; non-member $330; student $100.

Standard (November 17 - December 14, 2000) - ASAE member $329; non-member $370; student $125.

At the Conference (December 15 and after) - ASAE member $379; non-member $420; student $150.

Accommodation: The conference will be held at the Ala Moana Hotel, 410 Atkinson Drive, Honolulu, Hawaii 96814-4722. Special conference rate: $129 single/double (plus tax) - telephone + 1-808-955-4811; reservation fax + 1-808-944-6839. When making reservation, mention you are attending a meeting of the American Society of Agricultural Engineers.

Official airlines: American Airlines - + 1-800-433-1790. Discount Number - AN Number 1711UC (the greater discount is obtained if reservations are made up to 60 days prior to departure).

Further details from: ASAE Meetings and Conferences, 2950 Niles Road, St Joseph, Michigan 49085, USA.
tel. + 1-616-429-0300
fax. + 1-616-429-3852

5-9 February 2001
32nd Annual Conference and Expo - International Erosion Control Association
Las Vegas, Nevada, USA

Technical papers, poster presentations, training workshops, special sessions and progressive learning sessions on: arid/semi arid dust control; around the world; beach and shoreline stabilisation; bioengineering/biotechnical; business; erosion and sediment control; product applications; regulations, policies and programs; research; revegetation; slope stabilisation; stormwater management; streambank and channel stabilisation; tropical environments; urban and industrial development; water quality; watershed management; wetlands; wind erosion.

Abstract deadline: already passed.

Further details from: IECA 2001 Conference Program, PO Box 774904, Steamboat Springs, CO 80477-4904, USA
tel. + 1-970-879-3010
fax. + 1-970-879-8563
e-mail: ecinfo@ieca.org
http:/www/ieca.org

11-12 May 2001
Multidisciplinary approaches for soil conservation strategies
Müncheberg, Germany

Symposium topics: (1) Setting landscape and land use specific aims of soil conservation; (2) Socio-economic incentives and obstacles for the implementation of soil conservation strategies; (3) Case studies for multidisciplinary approaches to soil conservation on fields, farms, in landscapes and regions.

Field trip: Young Pleistocene landscape of Brandenburg, specific conflicts between agricultural landuse and landscape requirements for wildlife habitats and water quality will be demonstrated together with selected soil conservation solutions.
Meeting organised by the Center for Agricultural Landscape and Land Use Research (ZALF), European Society for Soil Conservation (ESSC) and Working Group on Soil Erosion of the Germany Society for Soil Science (DBG).

Registration and Abstracts (1 page A4): January 15, 2001 to:
Dr Nicola Fohrer, Institut für Landeskultur, Heinrich-Buff-Ring 26-32, D-35392 Giessen, Germany.
tel: + 49-641-9937385
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ESSC Council Members please note that the next Council meeting will take place in Müncheberg prior to the Symposium; it is scheduled for May 10, 2001 at 16.00 hours.

6-8 June 2001
ECOSUD 2001: Third International Conference on Ecosystems and Sustainable Development
Alicante, Spain

The meeting provides a forum for the presentation and discussion of recent work on the engineering and modelling aspects of ecosystems and sustainable development. Topics: application of ecological modelling in environment management; biodiversity; climate modelling and ecosystems; integrated modelling; environmental risk; sustainable development issues; lacustrine and wetlands ecosystems; forestation issues; computational modelling of natural and human ecosystems; natural resource management; environmental and ecological policies; erosion and soil management; soil and water remediation; water resources issues; ecotoxicology models; energy generation and conservation; mathematical and system modelling.

Organised by Wessex Institute of Technology.

Abstracts: no more than 300 words; submit as soon as possible to: shanley@wessex.ac.uk. Please note that full length papers must be presented camera-ready by 6 February 2001.

Further details from:
Susan Hanley, Conference Secretary, ECOSUD2001, Wessex Institute of Technology, Ashurst Lodge, Ashurst, Southampton SO40 7AA, UK.
tel. + 44 - (0)238-029-3223
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MULTIDISCIPLINARY APPROACHES TO SOIL CONSERVATION STRATEGIES

11-12 MAY 2001

Center for Agricultural Landscape and Land Use Research (ZALF), Müncheberg, Germany

- *setting landscape and land use specific aims of soil conservation*
- *socio-economic incentives and obstacles*
- *case studies on fields, farms and in landscapes and regions*

For further information, contact:

khelming@zalf.de or nicola.fohrer@agrar.uni-giessen.de

Please note: ESSC Council Meeting, 10 May 2001 at 16.00, precedes this symposium

AIMS OF THE SOCIETY

The ESSC is an interdisciplinary, non-political association, which is dedicated to investigating and realis[ing] soil conservation in Europe. The ESSC pursues its aims in the scientific, educational and applied sectors

- *by supporting investigations on soil degradation, soil erosion and soil conservation in Europe,*
- *by informing the public about major questions of soil conservation in Europe,*
- *by collaborating with institutions and persons involved in practical conservation work in Europe*

The ESSC aims at coordinating the efforts of all parties involved in the above cited subjects: research institutions; teachers and students of geosciences, agriculture and ecology; farmers; agricultural planning and advisory boards; industries and government institutions.

ZWECK DER VEREINIGUNG

Die ESSC ist einer interdisziplinäre, nicht politische Vereinigung. Ihr Ziel ist die Erforschung und Durchführung des Schutzes der Böden in Europa. Die ESSC verfolgt dieses Ziel auf wissenschaftlichem, erzieherischen und angewandtem Gebiet

- *durch Unterstützung der Forschung auf den Gebieten der Boden-Degradierung, der Bodenerosion und des Bodenschutzes in Europa,*
- *durch Information der Öffenlichkeit über wichtige Fragen des Bodenschutzes in Europa*
- *durch Zusammenarbeit mit Institutionen und Personen, die an der Praxis des Bodenschutzes in Europa beteiligt sind*

Die ESSC will alle Personen und Institutionen zusammenführen, die sich für die genannten Ziele einsetzen: Forschungsinstitutionen, Lehrer und Studenten der Geowissenschaften, der Landwirtschaftswissenschaften und der Ökologie, Bauern, landwirtschaftliche Planungs- und Beratungsstellen, Industrieunternehmen und Einrichtungen der öffentlichen Hand

BUTS DE L'ASSOCIATION

L'ESSC est une association interdisciplinaire et non politique. Le but de l'association est la recherche et les réalisations concernant la conservation du sol en Europe. L'ESSC poursuit cette finalité dans les domaines de la recherche scientifique, de l'éducation et de l'application:

- *en encourageant la recherche sur la dégradation, l'érosion et la conservation du sol en Europe,*
- *en informant le public des problèmes majeurs de la conservation du sol en Europe,*
- *par la collaboration avec des institutions et des personnes impliquées dans la pratique de la conservation du sol en Europe*

L'ESSC souhaite favoriser la collaboration de toutes les personnes et institutions poursuivant les buts définis ci-dessus, en particulier: institutions de recherche, professeurs et étudiants en géosciences, des agriculteurs, des institutions de planification et des conseil agricole, de l'industrie, et des institutions gouvernementales

OBJECTIVOS DE LA SOCIEDAD

La ESSC es una asociación interdisciplinar, no-política, dedicada a la investigación y a la realización de acciones orientadas a la conservación del suelo en Europa. La ESSC persigue sus objectivos en los sectores científicos, educacionales y aplicados, en al ámbito europeo:

- *promocionando la investigación sobre degradación, erosión y conservación de suelos,*
- *informanto al público sobre los principales aspectos de conservación de suelos,*
- *colaborando con instituciones y personas implicadas en la práctica de la conservación de suelos.*

La ESSC aspira a coordinar los esfuerzos, en los temas arriba mencionados, de todas las partes implicadas: centros de investigación, profesores y estudiantes de geo-ciencias, agricultura, selvicultura y ecología, agricultores, servicios de extensión agraria, industrias e instituciones gubernamentales.

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