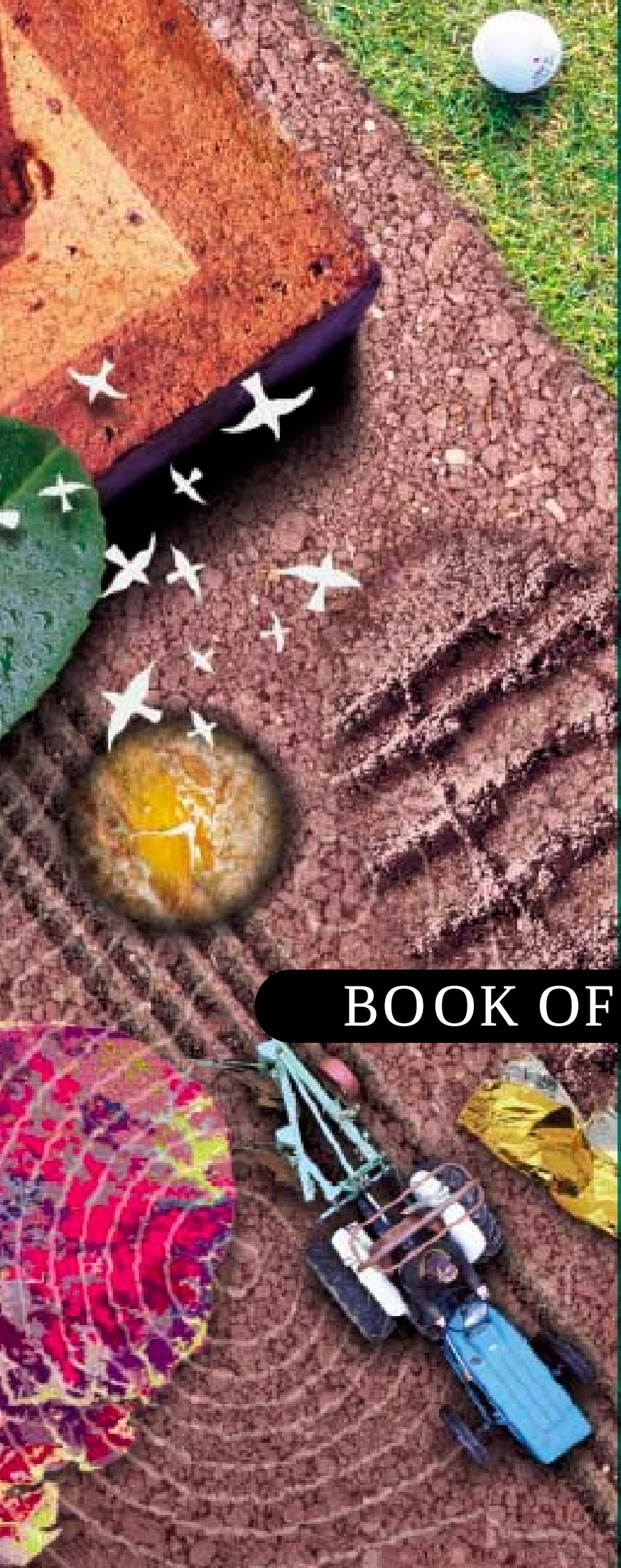


Cranfield
UNIVERSITY
Silsoe

SOIL EROSION AND SEDIMENT REDISTRIBUTION IN RIVER CATCHMENTS:

MEASUREMENT, MODELLING & MANAGEMENT IN THE 21ST CENTURY

BOOK OF ABSTRACTS

9th - 11th
September 2003

FOREWORD

On behalf of the National Soil Resources Institute, Cranfield University at Silsoe we would like to welcome you all to Silsoe and to the

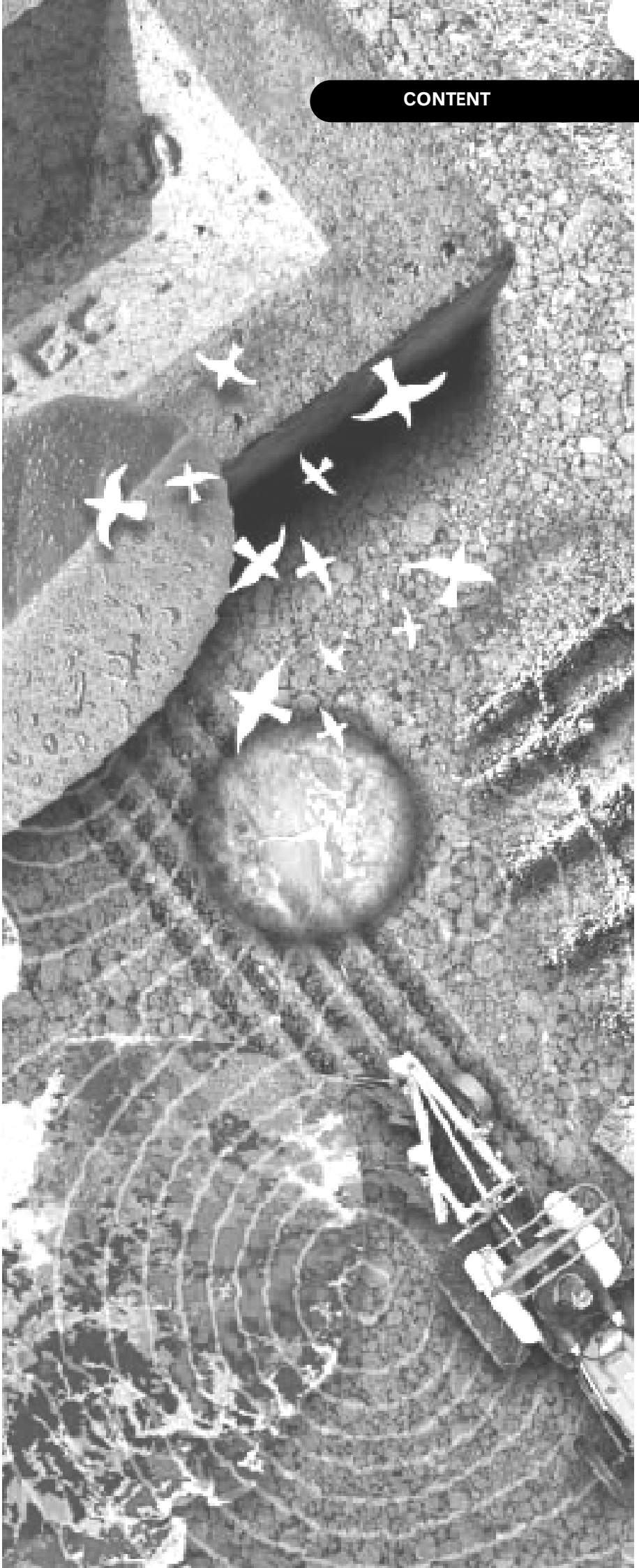
International conference on Soil erosion and sediment redistribution in river catchments: measurement, modelling and management in the 21st century.

There can be little doubt that issues relating to soils and sediments are moving up the political agenda. The recent publication of the EU Communication 'Towards a Thematic Strategy for Soil Protection' and the Water Framework Directive are clear signs that there is a need to develop and implement policy which consider soils and sediments. This growing interest has also resulted in the creation of networks, which provide a mechanism for scientists, managers and policy-makers to interact. But with attention being increasingly directed towards holistic land-river management, there is a need for a greater appreciation of the interaction between soils and sediments.
This conference is thus timely.

The conference aims to review the major achievements recently made in soil erosion and sediment redistribution research and management, and identify future requirements. Our delegates and speakers include key players in river basin soil erosion and sediment redistribution from sources to sinks, field to riverbank, from academia to policy and industry. The abstracts presented in this book examine the developments made in three themes – measurement, modelling and management – and cover a variety of scales (in both time and space) and geographical locations.

This promises to be a stimulating conference and we wish you a pleasant and enjoyable time

Phil & Alison



CONTENT

PROGRAMME

Tuesday 9th September

8.30 – 9.00 **Registration**

9.00 – 9.15 **Welcome:**

• Introduction to National Soil Resources Institute and Cranfield University at Silsoe – Prof. Mark Kibblewhite (Director)

• Introduction to the conference – Dr. Phil Owens

Theme: Measurement (Chair: Dr Phil Owens)

9.15 – 9.45 **Keynote – Prof. Des Walling (Exeter, UK)**

Tracing versus monitoring: new challenges and opportunities in erosion and sediment delivery research.

9.45 – 10.45 Three presentations

Ampontuah, E.O., Robinson, J.S. and Nortcliff, S. (Reading, UK). Assessment of soil particle redistribution on two contrasting cultivated hillslopes.

Belyaev, V.R., Golosov, V.N., Ivanova, N.N., Markelov, M.V., Tishkina, E.V. and Wallbrink, P.J. (Moscow, Russia and CSIRO, Australia). Assessing a contribution of different processes into soil degradation in two arable catchments of southern Russia.

Blake, W.H., Doerr, S.H., Wallbrink, P.J., Shakesby, R.A. and Humphreys, G.S. (Plymouth and Swansea, UK, and CSIRO and Macquarie, Australia). Tracing eroded soil in burnt water supply catchments, Sydney, Australia: linking soil magnetic signatures to water repellency.

10.45 – 11.05 Tea/coffee

Four presentations

Markelov, M.V., Belyaev, V.R., Belyaev, Yu.R., Golosov, V.N. and Tishkina, E.V. (Moscow, Russia). Sediment redistribution within a small catchment (Tver' region, North European Russia) during period of intensive agriculture.

Peart, M.R. and Ruse, M. (Hong Kong). A comparison of caesium-137 and erosion plot data from Hong Kong.

Shakesby, R.A., Doerr, S.H., Blake, W.H., Humphreys, G.S., Wallbrink, P.J. and Chafer, C.J. (Swansea and Plymouth, UK, and Macquarie, CSIRO and SCA, Australia). Soil water repellency variations and their effects on soil erosion in the burnt water supply catchment of Sydney, Australia.

Evans, R. (APC, UK). Land use and sediment delivery in England and Wales.

12.25 – 13.30 Lunch

13.30 – 13.55 Invited talk – Prof. Ellen Petticrew (UNBC, Canada)

Measurement of fine sediment storage in gravel bed streams of British Columbia

13.55 – 14.55 Three presentations

Evans, D.J. and Gibson, C.E. (Queen's, Belfast, UK). Sediment transport dynamics in the River Bush: implications for catchment management.

Farguell, J. and Sala, M. (Barcelona, Spain). Suspended sediment yield in a Mediterranean river basin: preliminary results.

Hejduk, L., Hejduk, A. and Banasik, K. (Warsaw, Poland). Suspended sediment transport during rainfall and snowmelt floods in a small lowland catchment (central Poland).

14.55 – 15.15 Tea/coffee

15.15 – 15.40 Invited talk – Prof. Ian Foster (Coventry, UK)

Lakes and reservoirs in the sediment delivery system: losing connectivity but gaining valuable palaeohydrological information?

15.40 – 16.40 Three presentations

Mant, J. and Hooke, J. (Cranfield and Portsmouth, UK). Vegetation in the ephemeral channels of southeast Spain; its impact upon sediment movement.

Mousouridis, A. (Georama Ltd, Greece). Sediment distribution patterns and properties due to landslide occurrence in flysch, W. Greece.

Zorzou, M., Foster, I.D.L. and Woodward, J.C. (Leeds and Coventry, UK). Five decades of sediment deposition in a Mediterranean mountain reservoir: spatial and temporal dynamics.

16.40 – 18.00 Tour of NSRI erosion laboratory and facilities

18.00 – 19.00 Poster session and preview of the Guidebook of Applied Fluvial Geomorphology (with drinks reception courtesy of the EPSRC Network on Sediment Dynamics and Morphology of River and Floodplain Systems)

Wednesday 10th September

Theme: Modelling (Chair: Dr John Quinton)

9.00 – 9.30 Keynote – Prof. Mark Nearing (University of Arizona, USA)

Can soil erosion be predicted?

9.30 – 10.50 Four presentations

Kinnell, P.I.A. (Canberra, Australia). Runoff, sediment concentration and predicting erosion on hillslopes within catchments.

Doerr, S.H., Shakesby, R.A., Ferreira, A.J.D., Leighton-Boyce, G. and Walsh, R.P.D. (Swansea, UK, and Aveiro and ESAC, Portugal). Soil water repellency: an important parameter in hydrological and erosion modelling?

Elliot, W.J. (USDA Forest Service, USA). The role of disturbance in forest soil erosion.

Hessel, R. (Alterra, Wageningen, The Netherlands). Effects of grid cell size and time step length on simulation results of a process based erosion model.

10.50 – 11.10 Tea/coffee

(Session Chair: Prof. Roy Morgan)

11.10 – 11.35 Invited talk – Dr Victor Jetten (Utrect, The Netherlands)

Simulating ephemeral gully incision: combining landscape indicators with process modelling

11.35 – 12.55 Four presentations

Ollesch, G., Sukhanovsky, Y., Demidov, V. and Rode, M. (UFZ CER, Germany). Measuring and modelling of winter runoff and snowmelt erosion in a low mountain catchment.

Sidorchuk, A., Nikora, V. and Smith, A. (Landcare, New Zealand). Probabilistic modelling of soil erosion.

Jarritt, N.P., Lawrence, D.S.L. and Whitehead, P.G. (Reading, UK). Simulating fine sediment delivery in lowland catchments: application of INCASed.

Licciardello, F., Nearing, M.A. and Zimbone, S.M. (UNICT, Italy and ARS, USA). Application of the WEPP model to a small Sicilian watershed.

12.55 – 13.55 Lunch

(Session Chair: Dr. Alison Collins)

13.55 – 14.20 Invited talk – Dr John Quinton (Lancaster, UK)

But does it reach the stream? Modelling the risk of spatially distributed sediment sources connecting with surface water bodies

14.20 – 15.00 Two presentations

Carter, J., White, S. and Anderton, S. (Cranfield and SEPA, UK). Modelling of sediment inputs to the Tees Barrage.

Schmelmer, K. (Bonn, Germany). Effectiveness of grass buffer strips in reducing runoff and sediment yield – field measurements and simulation results (EUROSEM, OPUS and VFSmod).

15.00 – 15.25 Invited talk – Prof. Colin Thorne (Nottingham, UK)

Fluvial audit approach to investigating, characterising and explaining sediment dynamics for river management and engineering.

15.25 – 15.45 Tea/coffee

15.45 – 18.30 Field excursion

19.30 Conference dinner

Thursday 11th September

Theme: Management (Chair: Dr Alison Collins)

9.00 – 9.30 Keynote – Prof. Roy Morgan (Cranfield, UK)

Managing sediment in the landscape: current practices and future vision

9.30 – 10.30 Three presentations

Walsh, R.P.D., Clarke, M.A., Bidin, K., Blake, W.H., Chappell, N.A., Douglas, I., Sayer, A.M., Sinun, W., Larenus, J. and Hanapi, J. (Swansea, Cranfield, Lancaster, Plymouth and Manchester, UK, and Malaysia Sabah, RBSB and DVFC, Malaysia). Changes in the spatial distribution of erosion within a selectively logged rain-forest catchment in Borneo, 1988-2002.

Watson, H.K. and Baijnath, S. (Natal, South Africa). A comparative study of soil erosion in communal and commercial lands in South Africa – land reform implications.

McHugh, M., Wood, G.A., Morgan, R.P.C., Walling, D.E. and Zhang, Y. (Cranfield and Exeter, UK). Mapping the delivery of eroded sediment from land to water: a useful management tool.

10.30 – 10.50 Tea/coffee

10.50 – 11.15 **Invited talk – Mr Jos Brils (TNO, The Netherlands)**

Environmentally, socially and economically viable sediment management according to SedNet

11.15 – 12.35 Four presentations

Visser, F. (ANU and CSIRO, Australia). Erosion management on a tropical floodplain with sugarcane cultivation.

Fiener, P. and Auerswald, K. (TUM, Germany). Potential and seasonal variation of grassed waterway effectivity in reducing runoff and sediment delivery from agricultural watersheds.

Theurer, F. (USDA, USA). Sedimentation in rivers and salmonids: management implications.

Nunny, R.S., Stone, P. and Walling, D.E. (Ambios and Exeter, UK). Land-use change, sediment fluxes and reef conservation in Central America.

12.35 – 13.00 **Invited talk – Dr Jane Rickson (Cranfield, UK)**

Management of sediment production and prevention in river catchments: a matter of scale?

13.00 – 14.00 Lunch

14.00 – 15.00 Software/methods/technology demonstrations

15.00 – 15.30 Coffee/tea

15.30 **Depart**

Assessment of soil particle redistribution on two contrasting cultivated hillslopes

Abstract: The particle size distributions of surface soils from two cultivated silty fields (Moorfield and Railway South) in Herefordshire, UK, were assessed by sampling on 20-m grids across the fields. Moorfield (8 ha) had a uniform landscape sloping mainly in a North-South direction while Railway South (12 ha) had complex undulating landscape characteristics. Size fractions were determined using laser granulometry. Samples along selected transects in the slope direction at Moorfield and reference (undisturbed and less eroded) samples were analysed for Cs-137 contents (Bq/kg). The distribution of various fractions suggests preferential movement of coarse to very coarse silt fractions (16 - 63 mm), which were found mostly at downslope or depositional areas. Upper slope samples had higher clay to fine silt (0.01-16 mm) contents. The upslope-downslope patterns of size fractions on the 2 fields were similar. Plots of Cs-137 activity versus various size fractions at areas of deposition (determined from activity above the reference) indicated increasing Cs-137 activities in upper-lower slope direction for medium to very coarse silt (8-63 mm) samples while the activity decreased in the same direction for the finer fractions. Soil erosion, sediment deposition and tillage may have contributed to the observed spatial patterns of soil particles.

Measurement

Author:

Ampontuah, E.O.

Department of Soil Science, University of Reading, UK

Co authors:

Robinson, J.S. and Nortcliff, S.

Assessing a contribution of different processes into soil degradation in two arable catchments of the Southern Russia

Abstract: The Stavropol upland is one of the most affected by soil degradation areas of the European Russia. Major erosion events are associated with heavy summer rainstorms. Local soils (chestnut) and subsoil materials (mainly loessy loams) are vulnerable to erosion. The most severely degraded soils are observed in areas where a variety of processes interact, namely sheet, rill and gully erosion, deflation and tillage translocation. Successful application of erosion counter-measures under such conditions require thorough understanding of a role of each process in overall denudation and sediment delivery from arable areas to valley network.

A number of different methods including direct erosion measurement, soil survey, 137Cs soil redistribution tracer and USLE-based modeling have been applied to assess qualitatively a contribution of sheet, rill and ephemeral gully erosion and tillage translocation into soil degradation and sediment delivery from two catchments. Case study sites located within the eastern part of the Stavropol upland differ significantly in local topography, soils and rainfall. Results of the study have shown that catchment morphology and morphometry are major determinants for a set and relative activity of soil degradation processes.

Measurement

Author:

Belyaev, V.R.

Faculty of Geography, Moscow State University, Russia

Co authors:

Golosov, V.N., Ivanova, N.N., Markelov, M.V., Tishkina, E.V., Wallbrink, P.J.

Tracing eroded soil in burnt water supply catchments, Sydney, Australia: linking soil magnetic signatures to water repellency

Abstract: The range of soil temperatures reached during fire may encompass major changes in soil water repellency and also in the mineral magnetic signature of soil and derived sediment. At temperatures >400ºC, large quantities of secondary magnetic minerals can be generated. At temperatures up to 300-400ºC, heating enhances repellency, whereas at higher temperatures repellency is destroyed, with implications for runoff and erosion dynamics. This work aims to link these phenomena in order to quantify soil/sediment export from sub-catchments of varying burn severity.

Repellency results suggest that 88% of surface soils measured in severely burnt areas have been rendered wettable by fire as opposed to only 29% in moderately burnt areas. Soil magnetic concentration data from these areas demonstrate a link between the presence of repellency and magnetic signature development in soils (i.e. severely burnt soils are most strongly enhanced). Where soil temperatures were too low to destroy repellency, an additional, but more complex relationship between the magnetic signature and the degree of repellency exists.

Measurement

Author:

Blake, W.H.

Department of Geography, University of Wales Swansea, Singleton Park, Swansea

Co authors:

Doerr, S.H., Wallbrink, P.J., Shakesby R.A. and Humphreys, G.S.

Management

Abstract: In the next few decades, Europe faces the large scale remediation of historically contaminated areas of sedimentation in many river basins (legacy of the past). One of the increasingly important challenges in European river basin management is the need to develop environmentally and socio-economically viable strategies and solutions for this environmental legacy. Another challenge is to further reduce water, and thus sediment, contamination from point sources and especially from diffuse sources. The European Sediment Research Network (SedNet) was established in order to help to structure and facilitate a harmonised European approach on these issues.

The SedNet objective is to form on a European scale inter-disciplinary links and trans-disciplinary bridges between scientist, engineers, sediment managers and those responsible for developing and implementing sediment related policy. It is clear that all sediment issues cannot be solved at once. The initial focus of SedNet is on understanding how contaminated sediment influences river system functioning and, from there, how contaminated sediment and dredged material can be managed.

The SedNet activities are financially supported for three years by the European Commission (EC) under the FP5 Energy, Environment and Sustainable Development programme and within area 1.4.1 on "Abatement of water pollution from contaminated land, landfills and sediments" (Thematic Network project, EC contract No. EVK1-CT-2001-20002, starting date: 1 January 2002). The main deliverable of this project will be a publication with guidance on sustainable sediment management (SSM), from local to river basin scale.

This abstract is extracted from "The SedNet Strategy Paper. The opinion of SedNet on environmentally, socially and economically viable sediment management". The paper was edited by TNO and NSRI, Cranfield University and is based on input of several institutes involved in the SedNet management. The paper is seen as organic and evolving, and will take into account developing views and consensus. The full paper can be downloaded, free of charge, via the SedNet website: www.SedNet.org. All who show interest in the issues raised are invited to comment and thus contribute to the evolution of this paper.

Author:
Brils, J.
SedNet co-ordinator, TNO Environment, Energy and Process Innovation (TNO-MEP), The Netherlands

Modelling

Abstract: Barrages have become a popular strategy for the development of estuarine areas. However, because they create an impounded body of water, they provide ideal conditions for sediment trapping. This results in a reduction in both water depth and also in water quality due to the association of sediment with high organic and pollutant loads. Present and long term sediment budgets therefore need to be established if these structures are to remain effective and viable in the long term. This paper examines the annual yield of sediment entering the Tees barrage, in the north-east of England. The high sediment yield reflects the very wet conditions of Autumn 2000. Also, various analysis techniques have been used to characterise a series of 66 events monitored upstream of the barrage between December 1999 and February 2002. Results from these analyses identified a number of controls on sediment transport at the event scale, including the influence of antecedent conditions on the relative timing of flow and sediment concentration peaks and the relationship between mean sediment concentration and peak discharge. The very wet conditions of Autumn 2000 appeared to trigger temporary changes in the sediment transport regime. However, results suggest that the characteristics of the sediment regime are now returning to pre-Autumn 2000 conditions.

Author:

Carter, J.

Institute of Water and Environment, Cranfield University, Silsoe, UK

Co authors:

White, S. and Anderton, S.

Soil water repellency: an important parameter in hydrological and erosion modelling?

Abstract: The reduced wettability of water repellent soils is thought to strongly enhance their runoff and erosion responses at range of scales. Despite these potentially important impacts, soil water repellency has to date not been addressed in erosion modelling. This may in part be associated with a general lack of awareness of its presence and effects and in part with the poor quantitative knowledge base on its impacts beyond the point or plot-scale. This paper (a) reviews the current quantitative knowledge base regarding the effects of repellency on soil erosion and (b) quantifies its effects in a case study carried out for forest soils in north-central Portugal by comparing the responses of the same soil or terrain at a range of scales for repellent and also wettable soil conditions. Examined are hydrological and erosional responses at the point- (0.002 m2), microplot- (0.12 m2) and plot-scale (16 m2), and hydrological responses at the catchment-scale (0.33 km2). Results indicate that repellency has a strong impact on soil hydrological and erosional response at the finer scales, but the magnitude of these impacts is reduced as the area of investigation is increased. The prospects, problems and potential approaches in addressing soil water repellency in soil erosion models are discussed.

Modelling

Author:

Doerr, S.H

Department of Geography, University of Wales Swansea, UK.

Co authors:

Shakesby, R.A., Ferreira, A.J.D., Leighton-Boyce, G. and Walsh, R.P.D.

Modelling

Abstract: Undisturbed forests erode very little. For example, in the northwestern U.S., "background" erosion rates in the order of 10 Mg/sq km are common. Disturbances due to extreme weather events, forest fires, severe logging practices, or a combination of these disturbances can lead to erosion rates up to 1000 times "background rates. Sediment may be generated by surface erosion, erosion of upland channels, debris flows in upland channels, or landslides from hillsides or roads. Excessive sediment generated from these disturbances is frequently stored in stream networks. Stored sediment is gradually routed downstream, particularly during years with high runoff events. Current observations suggest that decades may pass between significant erosion events, while forest streams gradually route accumulated sediment through the system. This paper describes recent research quantifying erosion rates due to roads, fires, landslides, and harvesting impacts. It then describes current efforts in modelling erosion using the newly developed GeoWEPP technology, to better understand the source, attenuation, and production of sediment from upland forested watersheds. Improvements to hydrology, flood routing, and sediment routing in GeoWEPP are suggested to make it applicable to modelling larger areas.

Author:

Elliot, W.J.

Soil and Water Research Work Unit,
Rocky Mountain Research Station,
USDA Forest Service, Moscow, USA

Sediment transport dynamics in the River Bush: implications for catchment management

Abstract: A significant decline in the survival of salmon from ova to smolt has been reported in the River Bush, County Antrim. Habitat degradation (sedimentation and eutrophication) was identified as a causative factor of this decrease in recruitment. Study sites were instrumented in July 2002 to investigate the sedimentation issue.

The transport of nine different size fractions of bedload and suspended sediment was monitored using pit traps and storm-integrating collection tubes. Total loads varied on a spatial and temporal scale between 0.001 and 48 kg m-1 week-1. Flow competence to entrain certain sizes of particles and sediment supply were limiting factors controlling both suspended and bedload transport.

Sources of sediment within the catchment were assessed using a combination of visual observations, GIS "erosion potential" maps and bank erosion monitoring. Possible source areas identified by these methods were fingerprinted using various diagnostic physical and chemical properties to elucidate the link between soil erosion and downstream sediment delivery.

This work has identified sources and sinks of fine and coarse sediment, as well as determining the magnitude, timing and type of sediment transported. Based upon this information, recommendations for manipulating sediment loads by changes in catchment management can be suggested.

Measurement

Author:
Evans, D.J.
Aquatic Sciences Department, Queen's University Belfast, Northern Ireland

Co authors:
Gibson, C.E.

Abstract: Channel length and land use in a catchment appear to be the main factors governing the delivery of sediment to streams in England and Wales. Sediment loads in rivers on average are highest in the extensively grazed uplands where channel lengths are greatest, which is often where peat moor occurs, and where forest plantations are widespread. They are lower in intensively grazed grasslands and least in the arable lowlands. Although erosion of cultivated land is widespread in parts of lowland England, this does not appear to be reflected in high sediment loads in main rivers. In the lowlands the delivery of sediment to rivers is related to erosion of the land, the removal of fines through field drains to ditches and streams and channel erosion. Presently, it is not easy to unravel the respective contributions of these sources, but it is important to do this if sedimentation and nutrient enrichment of rivers is to be tackled.

Measurement

Author:

Evans, R.

Department of Geography, Anglia Polytechnic University, UK

Measurement

Abstract: The aim of this paper is to present the sampling design and the preliminary results of suspended sediment transport obtained from a Mediterranean river. The Anoia drainage basin is located in the NE of the Iberian Peninsule and it drains an area of 926 km2. The underlying rocks are loams, clays and silts in the depressed and flat areas while limestones conform the mountain ranges. Agriculture is the most extended land use representing 55% of the surface, and is mainly based on the growth of cereals as wheat, barley and oats in the upper part of the basin, and vineyards in the lower part. Pine forests represent 35% of the surface, being the remaining 10% other uses. The average annual rainfall is about 600 mm in the lower part of the basin and 450 to 500 mm in the upper part. The existing relief within the basin causes these uncommon values of rainfall. Temporal distribution is uneven throughout the year, reaching the maximum during the autumn season, and is often of torrential type. Sampling has been performed weekly since October 2001 in five different sites, three along the main river and two in different tributaries. These sites were chosen according to the availability of discharge data. The upper part drains an area of about 200 km2 and the lower part 700 km2, both in gauging stations of the Water Authorities. Tributaries are of about 100 km2 each and sampled at gauging stations as well. During events, sampling frequency was increased to hourly intervals in the upper and lower part of the river using automatic samplers. In the sites where no automatic samplers were installed, manual sampling using a DH48 has been done. Values of suspended sediment concentration increase downstream from 4000 mg/l in the upper part of the basin to a maximum of 30000 mg/l in the lower part during the autumn season, and values recorded in the tributaries are of about 8000 mg/l in one of them and 6000 mg/l in the other. The sediment content in spring decreases to 900 mg/l in the upper part and 1800 mg/l in the lower part, and values recorded in the tributaries are1200 mg/l and 500 mg/l respectively. Soft underlying materials combined with bare soils due to agricultural practices and heavy rains during autumn make the area prone to produce high values of suspended sediment concentrations.

Author:
Farguell, J.
University of Barcelona, Spain

Co authors:
Sala, M.

Potential and seasonal variation of grassed waterway effectivity in reducing runoff and sediment delivery from agricultural watersheds

Abstract: Grassed waterways (GWWs) exhibit a great potential to reduce runoff, sediments and pollutants coming from agricultural watersheds. Our objectives were to evaluate the overall potential and the seasonal variation of a GWW in reducing runoff and sediment delivery. Both parameters were measured between 1994 and 2001 in two paired agricultural watersheds, one with the other without GWW. From these measurements the seasonal variation of in-outflow and sediment in-output in the GWW were calculated. Moreover the seasonal variation of the further runoff controlling parameters vegetation (hydraulic roughness) and soil (water content) were measured. During the eight observed years the GWW reduced runoff and sediment by 87 and 93%, respectively. Outflow and sediment output primarily occurred between February and April. This was mainly controlled by variations in inflow and sediment input. Changes in soil water content had only a minor effect most notably in Mai and June. In the tested GWW, where succession occurred for 8.5 years, the seasonal variation in hydraulic roughness was negligible. For conservation planning the knowledge of the great potential of GWWs in reducing runoff and sediment delivery and the strong correlation between GWW effectivity and inflow and input is highly relevant.

Management

Author:
Fiener, P.
TUM, Germany

Co authors:
Auerswald, K.

Lakes and reservoirs in the sediment delivery system: losing connectivity but gaining valuable palaeohydrological information?

Abstract:

Content

1. A brief history of lakes and reservoirs in the UK.

2. Lakes and reservoirs as components of the sediment budget (losing connectivity). Spatial location of reservoirs and their potential impacts on the spatial variability in connectivity with increasing catchment size.

3. Palaeohydrological benefits and pitfalls. Asking the right questions, choice of suitable sampling sites, temporal resolu tion, dating controls, post-depositional diagenesis.

4. Case studies:

a. History of sediment –associated phosphorus concentrations and loads – a review of trends over the last century in 14 upland and lowland reservoir–catchments in Britain.

b. Sediment yields and sources; the impact of land drainage land drainage.

5. Future questions

Measurement

Author:

Foster, I.D.L

Centre for Environmental Research and Consultancy, Coventry University UK

Suspended sediment transport during rainfall and snowmelt floods in a small lowland catchment (central Poland)

Abstract: Suspended sediment concentration and load was investigated in a small lowland (23.4 km2) catchment in central Poland. The catchment was instrumented to measure water level, discharge and suspended sediment concentration. The relation between sediment concentration and water discharge was analyzed for floods occurred during two hydrological years 1999 and 2000. The total load from each flood was calculated and compared to yearly load for each hydrological year. Different pattern of hysteresis relation of suspended sediment and discharge was measured for rainfall floods. The concentration and load of suspended sediment from rainfall floods was compared to snowmelt floods. The grain size distribution of suspended sediments was compared to mean discharge during floods.

Measurement

Author:

Hejduk, L.

Department of Hydraulic Engineering and Environmental Recultivation, Warsaw Agricultural University, Poland

Co authors:

Hejduk, A. and Banasik, K.

Effects of grid cell size and time step length on simulation results of a process-based erosion model

Abstract: With increasing computer power, process based models that use grids to discretisize space have become increasingly popular. For such models, the simulation results might depend on both grid cell size and, in the case of dynamic models, on the time step length used in the model. In this study, the dynamic soil erosion model LISEM was applied to a small catchment on the Chinese Loess Plateau. To study the effect of cell size and time step length simulations were performed for cell sizes ranging from 5 to 100 metres for a single time step length, and for time step lengths ranging from 2 to 120 seconds for a single cell size. The results show that the LISEM results vary considerably as a function of both cell size and time step length. For both increasing cell size and increasing time step length, the trend was a decrease in predicted discharge and predicted soil loss. The most important causes are likely to be a decrease in slope with increasing cell size and numerical dispersion of the kinematic wave solution, though these factors could not fully explain the soil loss trend. These results show that a choice for a certain grid cell size and a certain time step length should be made before calibration of the model.

Modelling

Author:
Hessel, R.
Alterra Green World Research,
Wageningen, The Netherlands

Modelling

Abstract: Suspended sediment concentrations in river channels are strongly linked to the erosion and delivery of fine sediments from catchment slopes and to the build-up and depletion of sediment stores on these slopes. INCASed is a new model which simulates sediment delivery processes at the catchment scale, based on an integrated model of slope and stream channel erosion, transport and storage processes. Many physically-based models of the generation and transport of fine sediments exist, although their effective application is often constrained by high data needs and calibration difficulties. INCASed uses a semi-distributed catchment representation with process-informed equations to overcome these problems whilst retaining physical representation. Of critical importance is the representation of soil erosion and sediment transport on catchment slopes using a series of lumped sub-catchments. INCASed models soil erosion by rainfall to generate a store of transportable sediment on the sub-catchment slopes. Direct runoff can deliver this sediment from the catchment slopes to the river channel. The model tracks sediment storage in the catchment between storms, allowing 'flushing' events to be reproduced. Applications of this model to the Upper Kennet and Enborne catchments in Southern England are used to demonstrate the effectiveness of this approach in reproducing both supply- and transport-limited conditions.

Author:
Jarritt, N.P.
Aquatic Environments Research Centre, School of Human and Environmental Sciences, University of Reading, UK

Co authors:
Lawrence, S.L. and
Whitehead, P.G.

Simulating ephemeral gully incision: combining landscape indicators with process modelling

Modelling

Abstract: Ephemeral gully erosion makes up a substantial part of the annual erosion in the Belgium loess belt (Nachtergaele, 2001). There are two types of ephemeral gullies in this region: narrow and deep winter gullies are formed in bare crusted fields, while shallow and wide summer gullies that are formed in tilled fields (often seedbeds). Until now, ephemeral gullies are not explicitly modeled. While some models simulate gully erosion (e.g. CREAMS, WEPP), there are actually few models that simulate the incision and formation of gullies (e.g. EGEM). The success of EGEM stems from the fact that the begin and end locations of the gully are specified a priori. Thus the length is known and the dimension is fairly well estimated. The goal of this research was to design a gully module for the spatial erosion model LISEM, capable of simulating gully formation. On the one hand this module should not be based on a physical 3D stress-strength simulation because the data is lacking, on the other it should not be completely empirical either, in particular the exact locations of the gullies should not be specified a priori.

Field observations (Vandaele et al. (1996), Desmet & Govers (1997), Nachtergaele, 2001) have shown that ephemeral gullies are usually formed in the same location. They designed a series of "wetness" type indices that combine drainage area and local slope, to delineate "critical" zones in the landscape that are prone to gully incision, with a,lower threshold of 4% slope below which no gullying takes place. Furthermore Nachtergaele et al. derived a general discharge-width relationship from observations in the Belgium loess belt and the Guadelantine area (ES). These relations were used in the LISEM-Gully module to arrive at the following simulation scheme:

1. the DEM of a catchment is analyzed with one of the critical zones algorithms

2. flow detachment and transport are simulated using streampower based equations for rill erosion.

3. when erosion takes place inside the critical zone:

a. the width of the flow and the gully width is determined by the Q-w relation;

b. the DEM is changed over the width of the flow according to the detachment or deposition;

c. the incision is marked as a gully when its cross section is larger than a square foot;

This module is tested on two sets of summer and winter gullies in the Kinderveld catchment (BE). Comparison between simulated and measured dimensions shows that:

• the locations are well determined when the surface drainage network is well defined (e.g. incorporating field boundaries),

• the gully dimensions of the measured gullies are well reproduced, but

• there are more gullies simulated than there are in reality (depending on the criteria for critical zone delineation),

• a second layer with a higher cohesion is needed to simulate summer gullies.

In general this method shows that erosion models have a lot to gain when landscape observations are incorporated. The model offers enough degrees of freedom to simulate ephemeral gullies while not needing much additional data above basic erosion modelling.

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Runoff, sediment concentration and predicting erosion on hillslopes within catchments

Abstract: While both raindrop impact and flow are involved in the detachment and transport processes, most erosion by rain results from sediment moving in surface water flow. Thus one approach to modelling erosion involves considering sediment discharge in terms of the product of runoff and sediment concentration.

At the small scale, raindrop impact in rain impacted flows increase sediment concentration above that associated with unimpacted flows. Three detachment-transport systems are involved; raindrop detachment and splash transport (RD-ST), raindrop detachment and raindrop induced flow transport (RD-RIFT), and raindrop detachment and flow transport (RD-FT). The first two are transport-limiting systems which produce a layer of loose material on top of the surface of the soil matrix. The two layered surface exhibits variable erodibility depending on the depth and content of the loose material. Most erosion models do not consider this effect.

At a bigger scale, prediction models like the Universal Soil Loss Equation (USLE) do not consider runoff as a primary factor. This results in the USLE in underpredicting low levels of erosion and overpredicting high level of erosion. This problem can be overcome via the USLE-M which includes runoff as a factor in accounting for event erosivity. This is also important to the modelling of erosion within grid cells where factors such as infiltration, vegetation and crop management cause runoff to vary spatially.

Modelling

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Application of the WEPP Model to a Small Sicilian Watershed

Abstract: Runoff and erosion in upland watersheds can have significant negative on-site and off-site environmental impacts. The choice and design of appropriate erosion control measures can be aided by reliable predictions of watershed response under different land use scenarios. In recent decades several simulation models have been developed in order to estimate and analyze soil erosion by water. Although many experiments have been conducted to evaluate the use of available watershed models, additional work is needed to assess and improve model reliability in environmental situations that can differ from those where the models were developed. The WEPP model is presently among the widely applied physically based models around the world. Several projects are being carried out to evaluate its capability of reproducing natural phenomena and to enhance its flexibility and reliability in different environments. In order to set up a database for the assessment of the performance of erosion models in Mediterranean areas, a monitoring program on a small mountainous watershed started in Sicily eight years ago. In this paper the results of the applications of the WEPP model to the observation period were analyzed in order to assess model implementation and performance in the experimented conditions of that site.

Modelling

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Vegetation in the ephemeral channels of southeast Spain; its impact upon sediment movement

Abstract: The effects of vegetation on channel morphology have been shown, in this research, to be an important component in the development of the ephemeral channels of southeastern Spain. Knowledge of plant species, their density, location and the morphological patterns formed along the channel bed are all critical to increasing our understanding of the changes observed in these rivers. Both the resistance of the plants to removal and their capacity to trap sediment play an important role in the response of these channels to flow events.

This paper discusses the results of a field study based in the Guadalentin Basin that includes ephemeral channels that typify the range of sediment types commonly found in Mediterranean areas. It has shown that in the short-term and for low magnitude flow events the vegetation can influence the processes and location of erosion and deposition within a channel. Over the longer-term and for high magnitude events the zonation and characteristics of the vegetation are influenced by the frequency and hydraulics of floods. Thresholds of flow conditions for the removal or survival of different types of plants have been identified and both their aerial and roots structure have been examined in terms of their ability to trap sediment.

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Sediment redistribution within small catchment (Tver' region, North European Russia) during period of intensive agriculture

Measurement

Author: Soil redistribution within small catchment for the last 300 years (period of intensive agriculture) has been assessed. The study catchment (area 0.81 km2) is located in southern taiga (coniferous forest) zone of the Russian plain and characterized by hilly post-glacial relief, mainly convex slopes, podzolic soils and maximum possible cultivation extent.

Four independent methods have been employed to quantify sediment redistribution pattern for different periods. These included direct soil survey, radionuclide tracers (137Cs and 210Pbex), and USLE-based modeling. Estimated rates of slope denudation are within the range 0,6-1,5 kg m-2 year-1. Two major zones of erosion can be distinguished, first at the upper convex slope break and second at the lower part of slope. Up to 40% of the mobilized sediment has been redeposited within arable fields. Deposition zones there are located along slope concavities and lower field boundaries. Accumulation on the valley bottom during the entire period of intensive cultivation has been estimated as 0,3-0,7 m. Intensity of sediment redistribution has remained low in comparison with forest-steppe and steppe zones of the Russian plain. Relatively higher rates were probably associated with initial phase of cultivation. Recent decrease of soil loss and valley bottom aggradation rates results from change of crop rotation since 1990.

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Mapping the delivery of eroded sediment from land to water: a useful management tool

Management

Abstract: This research was initiated to further the understanding of sediment contamination risk for watercourses in England and Wales. Suspended sediment is one of the most important sources of water pollution in UK rivers, with an annual cost to the economy of between £5.6 and £30 million, depending on the severity of the problem in any one year. The costs arise from the direct effect of sediment on aquatic life, the effects of phosphates and pesticides attached to the sediment and the losses in channel and reservoir capacity resultant upon sedimentation. The movement of suspended sediment is also highly costly before it even reaches watercourses, as it affects road surface quality and can bury crops and archaeological features. Understanding where the risk of sediment generation is greatest, and appreciating how efficiently sediment is delivered to watercourses, are important steps in control and mitigation.

To determine erosion risk, data from a series of national-scale erosion monitoring studies on erosion of upland, lowland grassland and lowland arable soils were used to determine the probability of erosion on different soils at various slopes, for a given return period, e.g. one-in-ten years. The efficiency of sediment delivery to watercourses was characterised using both the connectivity index (CI), which represents the relative efficiency of sediment transfer, and the connectivity ratio, which represents a scaling of the CI to provide a quantitative measure of the proportion of eroded sediment transported to watercourses in a catchment. Finally, using GIS, the probabilities of soil erosion were combined with the connectivity ratio to produce maps estimating the spatial distribution of annual sediment delivery from land to watercourses, for 903 catchments in England and Wales.

The results show that the greatest risk to water quality from erosion and diffuse pollution associated with sediment at a catchment scale occurs under arable agriculture in the west Midlands, Nottinghamshire and the Scottish Borders, and under upland grazing in the Lake District and north Wales. In total, there are 23 catchments in England and Wales with the probability that once in ten years at least 20 per cent of the catchment area will contribute sediment to watercourses at rates _ 0.35 m3 ha-1, a level considered to be sufficient to cause off-site sediment damage and pollution.

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Management

Abstract: Traditionally soil erosion has been associated with agricultural land but, in recent years, the need to protect against liabilities for pollution has encouraged engineering and construction companies to take greater care in erosion control. There is, however, very little contact between organisations with responsibility for erosion control on farmland and those concerned with non-agricultural areas. As a result, the civil engineering and construction industries have failed to learn from the agricultural experience and farmers have not taken advantage of what the erosion-control industry can offer. Yet, the basic principles of erosion control are applicable to all situations.

Erosion control in agriculture has changed over the last fifty years from top-down to bottom-up approaches with much greater emphasis on participatory techniques and indigenous conservation methods. The Land Care Movement in Australia has extended the philosophy to encompass all the stakeholders in the community, not just the farmers. A community approach has the ability to encompass all land use activities that might lead to erosion and sedimentation problems and can therefore contribute to a sharing of practices across the disciplines. As more countries follow the lead set by Germany and Switzerland and establish legislation for soil protection, erosion control will need to be based on defining acceptable performance criteria and adopting Best Management Practices. Ownership of erosion and sedimentation problems will become increasingly important at both individual and community levels. The community of stakeholders is the ideal body to address the issues because it is the community that suffers the consequences and gains the benefits of erosion control. Through community groups, erosion and sedimentation will increasingly be managed as a component of natural resource management based on the principles of integrated land management. Appropriate erosion models will need to be developed to enable such groups to undertake scenario analysis to find the most cost-effective solutions.

The effectiveness of community-based solutions will be dependent on how rapidly governments appreciate their potential and what procedures are put in place to provide an institutional framework within which they can operate.

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Sediment distribution patterns and properties due to landslide occurrence in flysch, W. Greece

Abstract: The Pindos Mountains geologic formations in Greece are extremely susceptible to widely occurring catastrophic landsliding. High rainfall values prevailing at the area, coupled with increased values of local slope, undermine river banks thus providing abundant sediments to the high powered braided rivers. Highly erodible siltstones, mudrocks and shales make up the bulk of the bedrock, causing instability, resulting in river incision. Significant topographic relief in the Acheloos River drainage basin, produces high stream gradients and thus the potential for high sediment transport capacity and flow energy per unit area of discharge. The tectonic setting of the study area is a typical allocthonous tectonic nappe, with intricate imbrications structures, and successive tectonic overthrusts. We have established the contributing area of surface runoff for a number of upland catchments in Mesochora, Central Greece and based on geophysical surveying we ascertained the occurrence of three different denudation mantles superimposed on bedrock. Initial sediment accumulation at the foot of the hillslopes causes streambed aggradation followed by rapid degradation triggered by high episodic discharges. Systematic measurements of flow measurements and sediment movement over a period of two years reveals a systematic pattern of landscape disturbance.

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Modelling

Abstract: Variability in soil erosion data from replicated plots is large. In a sense, one might think of the replicated plot as the best "real-world, physical model" of soil erosion that is possible. As such, one might further consider that the physical model represented by the replicate plot represents a sort of best-case scenario in terms of erosion prediction, or a baseline for which the performance of erosion prediction models might be compared. In this study, we consider data from replicated plot pairs for 2061 storms, 797 annual erosion measurements, and 53 multi-year erosion totals were used to estimate the variance of the erosion data. Coefficients of variation ranged on the order of 14% for a measured soil loss of 20 kg/m2 to greater than 150% for a measured soil loss of less than 0.01 kg/m2. The r2 for the fit for the replicate plot model was 0.76. This fit sets a benchmark for what one might expect for soil erosion models in general. This study also considers the source of the variation in erosion data from the theoretical basis of randomness vs. chaos, or unstable system behaviour, and what the implications of both are for erosion prediction in general. This presentation also discusses the critical nature of continuous simulation modelling in predicting erosion reliably. Erosional response can be described as a result of two overlapping temporal distributions: one of the driving force (e.g., rainfall amounts and intensities) and the second of the system resistance, both of which are highly variable. Results of simulation testing with the WEPP model indicate that 60 to 200 years of continuous simulation are required in order to quantify erosional response to plus or minus 10%. Single storm models simply do not have the capacity to accurately characterize erosional response of the complex and dynamic system involving climate, living biomass, and soil. We also discuss the role of erosion models given the limitations of prediction capability.

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Management

Abstract: Changing conditions within river basins represent one of four critical causes of degradation of the coastal zones of Central America, compounding with the effects of climate change, tourist pressures and over-fishing. The Watershed Reef Interconnectivity Scientific Studies (WRIScS) are concerned with quantifying land-derived effects. The study reported here focussed on how changing land-use effects the delivery of sediment and associated contaminants to the southern Belize barrier reef.

River monitoring showed that, in global terms, runoff is high and suspended sediment yields are low. Man is modifying this natural situation through land clearance for plantation-type cultivation of citrus fruits and bananas. Results indicate that this change in land-use produces an order of magnitude or greater increase in fine sediment input to the rivers.

Coastal waters are characterised by low energy levels most of the time. Most river sediment is delivered to the sea at relatively high concentrations during short-lived flood events, encouraging rapid accumulation on the seabed close to river mouths. These deposits are susceptible to onward transport as a result of wave and current action. However, the latter operate independently of catchment processes. Thus the turbidity regime at the reef is effectively decoupled from the effects of changing river inputs due to land-use change.

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Measuring and modelling of winter runoff and snowmelt erosion in a low mountain catchment

Abstract: Recently, results of erosion studies in northern countries as well as central and eastern Europe suggest that snowmelt erosion is of importance for non-point source pollution. Contrary to rainfall erosion, flow concentration during snowmelt induces rill development only. Soil moisture and frozen soil conditions trigger both, runoff generation and soil erodibility.

The objective of this paper is to characterise the spatial dynamic of soil erosion processes and sediment source areas during snowmelt. The experimental catchment “Schäfertal” (NE- Germany) will be used as an example. The results, which were obtained so far, indicate that slope processes are responsible for high suspended sediment concentrations and net erosion in the catchment. River bank erosion is of secondary importance for the sediment yield but phosphorus loss can be high.

A model system for continuous simulation of winter runoff generation in the catchment, which is passively coupled to an snowmelt erosion model, is presented. A new approach to calculate snowmelt erosion, that also accounts for frozen soil conditions is applied for the “Schäfertal” catchment.

Modelling

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A comparison of caesium-137 and erosion plot data from Hong Kong

Abstract: The present case study investigates the relationship between measured depths of erosion and 137Cs totals on three erosion plots in Hong Kong. Soil erosion has been measured on three 6m x 20m plots utilising 30 erosion pins per plot. One plot has been left undisturbed with a complete vegetation cover for 68 months while the other two have had the vegetation cover removed for 45 and 33 months respectively. The vegetated plot recorded 0 mm of erosion and has a measured 137Cs content of 3.92 Bq Kg-1 whilst the other two plots experienced 24.5 and 57.4 mm of erosion and had 137 Cs contents of 1.89 and 1.48 Bq Kg-1 respectively. 137Cs levels were based on a mean of 10 x 30 cm cores extracted from each plot. The data suggests that soil erosion produces a quantifiable reduction in the 137Cs inventory in the soil and that 137Cs may be used to identify areas of soil erosion in Hong Kong. Two complicating factors may need to be considered: the association between rainfall and altitude in Hong Kong and the role of mass movement in slope denudation.

Measurement

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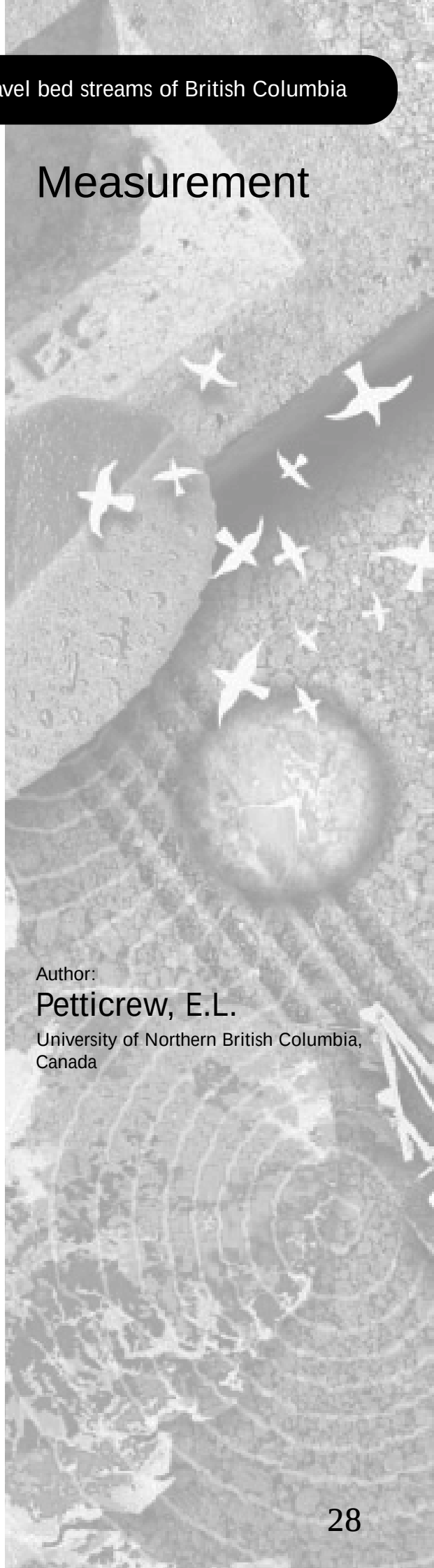
Measurement of fine sediment storage in gravel bed streams of British Columbia

Abstract: Fine sediment management in an important component in maintaining quality habitat in rivers. Fish spawning habitat is sensitive to increases in fine sediment as eggs can be smothered and/or interstitial oxygen can be depleted. Perturbations in watersheds (wildfires, reservoir management flows, forest harvesting, road and bridge construction) can result in the introduction of fine sediment to river channels. In British Columbia, Canada, where salmonid populations are large and of significant economic value the management of watershed delivery of fines to spawning streams is vital.

Details of several case studies measuring the fine sediment stored in gravels of fish bearing streams following watershed disturbance will be presented. As well a study which has occurred in a non-disturbed stream, but which has investigated the implications of the transfer and storage of fine sediment in a highly productive salmonid stream will be included.



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But does it reach the stream? Modelling the risk of spatially distributed sediment sources connecting with surface water bodies

Abstract: The risk of sediment associated with overland flow and sediment reaching streams and surface waterbodies, where it can cause pollution is a combination of a source connecting with a sink. While this has been recognised in the literature, few models explicitly take account of the delivery of material to water bodies and how this relates to the source material. In this paper we present a new approach whereby the sources of material reaching the stream is calculated and delivery maps produced of high an low risk areas. We do this by characterising the flow pathways using a flow algorithm and using soil and land use information to characterise the source. Sediment concentrations are generated using a simple relationship based on slope, erodibility, and rainfall. The proportion of sediment is then routed through the landscape and a memory is retained of the contributions of individual pixels to the delivered sediment. We demonstrate this using data from the Petzenkirchen catchment in Austria and compare our calculated risk zones with mapped areas of erosion and runoff.

Modelling

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Management of sediment production and prevention in river catchments: a matter of scale?

Abstract: Accurate and reliable data on the effectiveness of sediment control techniques are needed at the policy-making (governmental) level, as well as at the implementation (land user) level. The scale at which data on erosion control practices are generated and collated can influence the performance of these practices: for example, can detailed, process-based data (often generated in the laboratory from plots ≤ 1 m2) be extrapolated to the field plot or even sub-catchment scale? Whilst better understanding of the processes affecting soil erosion control is gained from small plot studies, can the same performance apply at the field, sub-catchment or catchment scale?

This paper presents data where erosion control techniques have been performance-tested at different scales, and analyses the variability of results as a function of spatial (plot) scale. Examples include soil erosion control using geotextiles, conservation tillage techniques, and vegetation from the individual plant scale up to the land use scale. The implications of the findings for policy makers, developers of erosion models and land use managers are discussed, using a case study from a recently funded EC demonstration project on soil and water protection methods in northern and central Europe.

Management

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Effectiveness of grass buffer strips in reducing surface runoff and sediment yield – field measurements and simulation results (EUROSEM,OPUS and VFSmod)

Modelling

Abstract: Field studies were conducted to determine the surface runoff reduction and sediment trapping effectiveness of grass buffer strips. Though several data concerning this topic are already available, it is difficult to compare them because of the wide range of methods used and soil conditions encountered (moisture, plant cover etc.). In our studies results are obtained using natural and simulated rain (40 mm/h). The controlled soil conditions make possible to determine the influence of rain structure, plot length, buffer length and length ratio (erosion area : buffer area) on buffer performance.

The lower erosivity of the homogeneous simulated rain causes lower sediment concentration than natural rainfall do. Higher runoff rates caused by higher peak intensities of natural rain or by greater plot length result in a more concentrated flow inside the grass buffer, even if sheetflow dominates the erosion area. So a lesser portion of the buffer area is involved in reducing runoff amount by infiltration. Runoff reduction diminishes this way. Runoff reduction is much more affected by rain structure, plot length, buffer length and length ratio than sediment removal, which is always high.

The experimental results are simulated with EUROSEM (MORGAN, R.P.C. et al. (1998): The European Soil Erosion Model (EUROSEM): documentation and user guide version 3.6. – Silsoe College, Cranfield University, Silsoe, UK) and a new, in 2002 by Roger E. Smith created version of OPUS (SMITH, R.E. (1992): OPUS: An Integrated Simulation Model for Transport of Nonpoint-Source Pollutants at the Field Scale, Vol. I: Documentation. – U.S. Dept. of Agriculture, Agricultural Re-search Service, ARS-98).

Sedimentation pattern inside the buffer strip and particel size distribution depending on flow distance were studied. The modell VFSmod (MUNOZ-CARPENA, R. & J.E. PARSON (1997): VFSMOD – Vege-ative filter strips hydrology and sediment transport model. – http:// www.icia.rcanaria.es/servicios/ vfsmod/) was validated concerning deposition geometry.

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Soil water repellency variations and their effects on soil erosion in the burnt water supply catchment of Sydney, Austrailia

Abstract: Fire can induce, enhance, destroy or have no detectable effect on soil water repellency. These outcomes may also differ between surface and subsurface soil. The hydrogeomorphic impacts of these various repellency characteristics are difficult to isolate from other fire-related changes (e.g. litter and vegetation destruction), but are required in order to understand the causes of post-fire soil erosion responses. For two forested subcatchments (one mainly moderately burnt, the other mainly severely burnt) within the main water supply catchment of Sydney, this paper explores (a) the effects of different fire severities on soil water repellency and (b) associated erodibility, erosion and deposition of soils. Repellency of the soils is shown to be a pre-fire characteristic, widely retained in the moderately burnt catchment but mostly destroyed in the upper 1-5 cm of the soil in the severely burnt catchment. The main post-fire hydrogeomorphological changes have been widespread erosion of the topsoil together with its local redistribution on the slopes but also its delivery to foot-slope locations and streams. The effect on the highly erodible sandy subsurface layer has been less predictable: it seems to have undergone only comparatively localised redistribution. Differences in the erosional response of the two subcatchments are explored.

Measurement

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Modelling

Abstract: The interaction between water flow and structured soil has a strong stochastic component due to both great variability of the geomechanical structural and electro-chemical forces in real soil and overland flow turbulence. This suggests that the use of the probability density functions (PDF) and the spectral density functions (SDF) for the key variables in the soil erosion models instead of their mean values should provide a better description of erosion processes.

The detachment rate of soil aggregates can be parameterised using several approaches. One of them defines the detachment rate as the product of the mean concentration of unstable soil aggregates in the bed surface layer and the vertical velocity of soil aggregates. Both these variables can be defined using the probabilistic field of driving and resisting forces, described by PDF of flow parameters and soil characteristics.

Another approach in modelling the upward sediment flux considers it as the product of the volume of unstable aggregates in the bed surface layer and the frequency of its detachment. This function may be defined from power spectrum of flow velocity and probabilistic properties of soil structure.

To study probabilistic fields of driving and resistant forces in soil erosion, these variables can be associated with stochastic components of evolution laws in dynamic cellular models. Further, these cellular models can be coupled with a cell-based hydrodynamic model such as the Lattice Boltzmann (LB) model. The LB model involves the evolution of the momentum distribution at each point on a spatial grid, and is capable of generating the flow field past the complex granular boundary, from which the relevant pressure forces may be derived. A unifying dynamic computational model such as this may be utilised in conjunction with the analytic approaches mentioned above, in order to formulate a broad representation of the stochastic components of soil erosion and its spatially varying characteristics.

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Management

Abstract: Salmonid species include: salmon, trout, grayling, char, & whitefish. Some are anadromous, some are not. Anadromous salmonids are born in fresh water, spend their adult lives in saltwater oceans, and return to their natal locality to spawn. Pacific salmon are anadromous and also semelparous, dying after they spawn. Atlantic salmon are anadromous but may spawn more than once. The same is true about anadromous trout such as seatrout (cutthroat) & steelhead (rainbow)—they may spawn more than once. Management of existing stocks to protect, enhance, or restore salmonids, requires recognizing and protecting salmonids throughout their entire life cycle. The salmonid life cycle consists of the: (1) embryo & sac-fry stage within their spawning redds; (2) juvenile stage in their rearing habitat; (3) smolt stage during downstream migration; (4) adult stage while in the ocean; (5) return spawner stage during upstream migration to their natal locality; and (5) spawning. Obstacles to continued salmonid survival or restoration include: (1) smothering within the redd due to reduction to lethal levels of dissolved oxygen (DO); (2) failure to emerge from the redd as a result of sediment entombment and weakened physiological conditions prior to fry emergence due to critical levels of DO &/or water temperatures during their incubation period; (3) critical or lethal rearing habitat conditions such as elevated water temperatures, too many predators, & other competitive species; (4) man-made migration impediments such as dams and reservoirs; (5) ocean predators including commercial overfishing; (6) return migration problems including recreation overfishing, predators, and the same man-made impediments as the downstream migration except that they are more severe migrating upstream; and (7) more predation and critical or lethal environmental upstream spawning conditions. A single, successful, typical redd, under reasonable environmental conditions, may start with 3500 eggs, producing 2800 emerging fry, leading to 300 juveniles. Only 50 smolts will reach the ocean, with four of these returning as adults from the ocean, a pair of adults arriving at the spawning grounds, and then successfully spawning—beginning the cycle anew. Interference with, or failure to properly manage any portion of, their life cycle can be fatal to their continued survival. This paper will concentrate on and discuss the environmental problems, with their management implications, confronting the embryo, sac-fry, & juvenile life stages (spawning & rearing habitat). Special emphasis will be placed on possible hidden pervasive and insidious embryo & sac-fry conditions within a redd that can be caused by excessive non-point source sedimentation, and tools, such as AGNPS, which can be use to quantity & evaluate their mortality.

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Management

Abstract: In tropical north eastern Australia concern is a growing about the possible negative impacts of increased sediment export from river catchments on coastal and riverine ecosystems. Sugarcane cultivation on the floodplains of these catchments is thought to be an important supplier of the excess sediment. The intensively cultivated, low-gradient sugarcane landscape contains a number of potential sediment sources (e.g. drains, water furrows, fields). Prior to the present study no information existed on the importance of any of these sources. Direct measurements proved very important to obtain sufficient understanding of the erosion and sedimentation processes within each potential source. Such information is necessary for the development of suitable soil management strategies. Alternative methods (e.g. tracers, modelling) were not likely to provide similar insight. A sediment budget was used to confirm the observed erosion and deposition rates. The estimate of the total amount of sediment generated from the sources minus redeposited sediment is very similar to estimate of the amount exported from the studied area. This is a very encouraging result, although analysis of potential errors in all components of the sediment budget still indicates high uncertainty.

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Tracing versus monitoring: new challenges and opportunities in erosion and sediment delivery research

Measurement

Abstract: Traditionally, information on soil erosion rates and catchment sediment yields has been collected using erosion plots and measurements of sediment yield at catchment outlets. In both cases, measurements are commonly undertaken on a continuous or frequent basis over periods of several years, in order to assemble representative results, Data collection activities of this nature can, for convenience, be seen as falling with the broad remit of monitoring programmes. Such monitoring programmes will undoubtedly continue to be an important, if not essential, source of information in erosion and sediment delivery research. However, changing perspectives and information requirements have generated the need for new approaches. For example, in many situations preoccupation with the on-site impacts of erosion and soil loss has been replaced by concern for offsite or downstream impacts and thus for the transfer and fate of sediment mobilised by erosion within a drainage basin. Equally, concerns relating to downstream sediment yields have extended beyond the magnitude of the sediment flux and its potential significance for reservoir sedimentation, to a broad range of sediment-related problems impacting on sustainable water resource development and the protection and conservation of aquatic ecosystems. These concerns will frequently focus attention on sediment quality and more particularly levels of sediment-associated nutrients and contaminants, which in turn introduces the need for information on sediment source. Pressures to develop effective sediment control strategies within catchment management programmes similarly generate requirements for information on sediment sources and source-channel linkages, in order to deploy control measures to maximum effect and thus to maximise the benefit from limited resources. Furthermore, recent advances in the development of distributed erosion and sediment delivery models have generated requirements for spatially-distributed data on erosion and sediment delivery for model testing and validation. Against this background, information requirements in the field of erosion and sediment delivery research have extended to embrace the entire sediment budget of a catchment, including sources, transfers, sinks or stores and outputs. Equally, there is an increasing need for spatially-distributed data and for data that can be assembled relatively rapidly, without the need for expensive long-term monitoring programmes. Faced with this challenge, sediment tracing techniques have assumed increasing importance as a means of generating the required information. Environmental radionuclides, including Cs-137, excess Pb-210 and Be-7, have proved particularly valuable in this context, in view of their essentially 'natural' occurrence, their almost universal applicability and the potential to assemble retrospective information on the short- or medium-term response of a landscape to erosion and sediment delivery on the basis of a single site visit. Examples of the use of sediment tracing techniques to meet contemporary information requirements in the field of erosion and sediment delivery research, based on the work of the author and his co-workers, will be introduced.

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Changes in the spatial distribution of erosion within a selectively logged rain-forest catchment in Borneo 1988-2002

Abstract: This paper explores changes in the spatial distribution of slope erosion in relation to river sediment load of an instrumented rain-forest catchment at Danum Valley in Sabah that was selectively logged in 1988-89. Results from a network of repeat-measurement erosion bridge sites are used to assess changes in erosion rate in different parts of the post-logging regenerating forest mosaic between 1990 and 2003. These are supplemented by erosion plot data of 1989-91; a nested array of instrumented within-catchment weirs and erosion plots installed in 1995-96; and rainfall simulation plot experiments in 1999-2000. The principal sources of sediment in the first five years after logging were heavily logged slopes, skid trails, log-landings, and surfaced and unsurfaced logging roads. By 5 years after logging, erosion rates on skid trails and logged slopes had declined with revegetation towards primary forest levels. The principal sources of sediment from 5-13 years after logging have been: road-associated landslides (and subsequently their scars and toe deposits); knick-points of gullies of unsurfaced roads connected to the stream network; collapsing debris dams; and still unvegetated log-landing areas. The magnified importance (relative to under primary forest) of extreme rainstorm events in sediment mobilisation and transport in the catchment is demonstrated.

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A comparative study of soil erosion in communal and commercial lands in South Africa – Land reform implications

Abstract: The perception that soil erosion is more severe and primarily caused by overstocking and poor cultivation practices, in areas under traditional African communal landuse as compared with white owned commercial farms, still pervades in South Africa today. This perception is undermining the national Land Reform Programme which aims to achieve a more equitable racial distribution of land ownership. A number of studies carried out in various parts of the country to date have verified this perception. Others have shown that while gully erosion is better represented in the former, sheet erosion is more extensive in the latter. Because of significant differences in climate, geology, soils and vegetation between the land ownership categories considered, none of these studies have been able to conclusively attribute differences in soil erosion to land use practices. Two sets of 1 10 000 orthophotos taken before and after a major flood were used to compare soil erosion in biophysiographically equivalent adjacent communal and commercial lands While sparsely covered surfaces potentially susceptible to erosion were better represented in the communal lands, actively eroding bare surfaces were more prevalent in the commercial lands. Gullies were better represented in the commercial lands before the flood and subsequently increased in both land ownership categories as a consequence of it. This increase was greater in the communal lands and correlated with the distribution of poorly sited, non- macadamized roads. These findings suggest that the effect of land ownership change on the soil resource may not be so onerous given that the conditions of roads to and on commercial farms is generally much better than those serving the country's communal lands.

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Five decades of sediment deposition in a Mediterranean mountain reservoir: spatial and temporal dynamics

Abstract: This paper presents data from the Ladonas Reservoir in central Greece that was formed following dam construction in 1956 and inundation of the valley floor of the Ladonas River. The main reservoir is over 6 km in length and comprises a series of narrow basins bounded by steep bedrock walls and wider and shallower basins flanked by tributary fans. Our work on the sediments that have accumulated in the basin since 1956 has two main aims: 1) to establish the spatial pattern of sedimentation across the reservoir using pre-impoundment maps and bathymetric survey and 2) to elucidate any temporal trends in sediment accumulation using sediment cores dated by fallout radionuclides (including Cs-137). The maximum depth of sedimentation in the largest basins is approximately 5 m and the spatial pattern of sediment accumulation is presented in a GIS model. Data from the sediment cores and radionuclide chronology are used to check the bathymetric survey estimates of sediment yield and allow temporal variations in sediment accumulation to be estimated. This paper outlines our approach, presents both datasets and discusses the advantages and disadvantages of this approach in a Mediterranean mountain environment.

Measurement

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