NEWSLETTER

1/2011

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A Pleistocene cover-sand deposit with a podzol soil profile in Wekeromse Zand, Veluwe, The Netherlands. The profile shows a grey leached horizon over a brown illuvial horizon, covered with medieval drift sand (photo by Pim Jungerius, Amsterdam, The Netherlands).

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Contents

This issue of the ESSC Newsletter presents the 16th of our 'Guest Editorials.' This is an opportunity for leading authorities in the soil science community to offer their perspectives on issues relating to soil conservation. This contribution is from Professor Pieter Jungerius (Amsterdam, The Netherlands). Eventually, we envisage this collection of essays developing into an authoritative book.

Soil Erosion and Conservation in Natural and Semi-natural Landscapes

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Erosion is one of the five soil degradation processes listed in the proposed Soil Directive of the European Union (European Commission Environment, 2006)). It is also the major conservation problem of the ESSC, according to the aims of the Society published in every Newsletter: *"Supporting investigations on soil degradation, soil erosion and soil conservation in Europe."* The other four soil degradation processes of the Soil Directive: organic matter decline, salinization, compaction and landslides, are not specifically mentioned. Sixty years ago, in the Soil Survey Manual of the US Department of Agriculture of 1951, soil erosion in need of conservation was called *accelerated soil erosion,* to distinguish this anthropogenic variety of the process from natural soil erosion. Natural soil erosion was defined on p. 251 of the Soil Survey Manual as *a* ***constructive*** *as well as* ***destructive*** *process, geologically speaking responsible for* ***wearing down*** *higher points and* ***elevating*** *lower points.* Admittedly this two-pronged effect of the erosion process is confusing, but it should be familiar to the many members of ESSC with a geomorphological background, because they are aware that erosion processes include down wearing as well as raising parts of the landscape. This also applies to accelerated soil erosion, as demonstrated by experiments of the University of Leuven: a cover of colluvium on lower slopes may reduce agricultural production as much as the formation of rills and gullies on upper slopes. Deposition of colluvium is the agricultural counterpart of elevating the land as part of the natural erosion process.

In applied soil science and agriculture generally, the term soil erosion is now used in the restricted, anthropogenic sense. This overlooks the fact that natural soil erosion has formed most landscapes that are affected by accelerated soil erosion, and continues to do so, because natural erosion never stops as long as the conditions are favourable. Even where the accelerated soil erosion processes are dramatically visible as gullies or rills, the natural erosion processes that have shaped the relief in the course of geologic time usually remain evident in the shape of the land. Moreover, the total output of waste from catchments is often more dependent on natural processes than on agricultural activities. This Guest Editorial is an account of a geomorphologist's participation in soil erosion and, where needed, conservation research in natural and semi-natural landscapes. The following section underlines the geomorphological importance of natural soil erosion.

The formation of a cuesta by differential soil erosion.

The role that is traditionally ascribed to qualities of the underling rock is in point of fact often due to the response of soil material to sub-aerial erosion processes. Where concordant sedimentary rocks dip gently, which they do over enormous areas of the earth's surface, they give rise to asymmetric hill ridges known as 'cuestas.' It is the stubborn belief of authors of geological and geomorphological textbooks that these landforms are due to differences in 'hardness' or resistance of the underlying beds. They fail to see the that rocks are seldom exposed on the dip slope or in the foreland of cuesta landscapes, with the exception of the steep front which is not subject to downwearing but to backwearing and plays a passive role in the development of the cuesta. If there has been any differentiating process at work in carving out the cuesta, it is much more plausible to hold the resistance of the weathering and soil materials responsible, because they are exposed to the subaerial erosion processes. In other words, a cuesta is formed by differential soil erosion.

The significance of this principle is evident in situations where a 'weak' rock develops into a soil which resists erosion. The escarpment in the soft Upper Coal Measures in Nigeria is a case in point (Figure 1). The resistance is due to a protective armour formed in the soil of the Upper Coal Measures by plinthite that hardened on exposure into ironstone concretions. The concretions make the soil over the soft rock more resistant to erosion than the sandy soil of the false-bedded sandstones underneath. The layer of ironstone concretions is the result of the poor subsoil drainage (Jungerius, 1964). Termites bring the clay in between the ironstone concretions to the surface, where it is removed by the prevailing slope wash processes, leaving the concretions at the surface as an erosion remnant. In the course of geologic time this protective ironstone cap turns the originally soft rock into a 30 m high cuesta front.

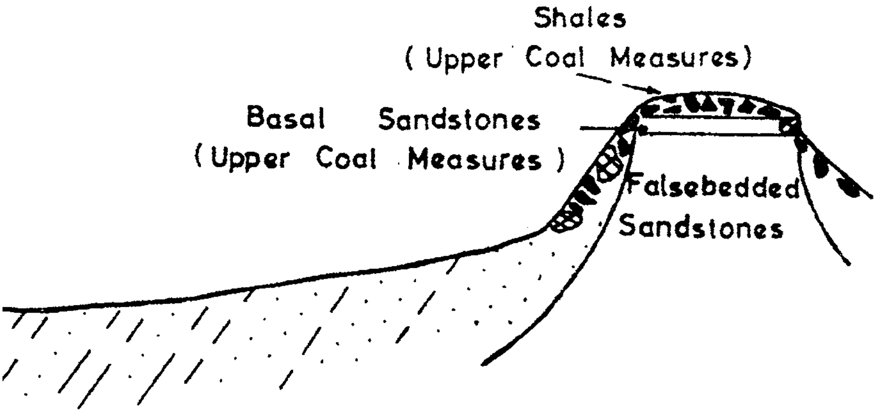

Figure. 1. The Upper Coal Measures cuesta in Nigeria.

In Europe, normal or natural soil erosion processes prevail in semi-natural landscapes such as forests, dunes and drift sands. On the summits and upper slopes of these landscapes the downwearing may be so slow that soil formation can keep pace, resulting in permanently complete soil profiles. In that case there is no need to consider conservation measures. In contrast, if erosion is strong enough to erode the soil cover on upper slopes and colluvium is deposited on lower and basal slopes, this may call for conservation measures.

Soil erosion in forests

A key role in soil erosion in forest is played by soil fauna. The widespread notion that erosion is absent in European forests, is misleading. The ubiquitous hilly or even mountainous relief formed under this type of vegetation is proof to the contrary. It is surprising how active erosion processes can be in forests! Measurements in small catchments in a hilly landscape in Luxembourg, which is representative of the relief of much of Western Europe, showed suspended solid outputs to be a factor 2-5 lower in dense, broad-leaved forests than in arable land, but higher than in grassland (Imeson and Vis, 1984).

The effects of soil fauna in forest soil and landscape development are manifold and have been introduced by Anton Imeson as a major research theme of the University of Amsterdam in the early 1970s. He started with monitoring the contribution of molehills to the output of solids from wooded catchments, and showed this explained much of the stream incision in the forest-clad Ardennes (Imeson and Kwaad, 1976). By then studies of the geomorphological significance of soil fauna had already begun at the Hebrew University of Jerusalem. It is a chapter of ecological geomorphology that we owe to Darwin. I am convinced that his book *"The formation of vegetable mould through the action of worms. With observations on their habits",* first published in 1881 and reprinted several times since, will be studied long after his theories on the origin of the species are considered dated. The President of our ESSC wrote about Darwin's contribution to soil science and geomorphology in the Opinion Column of the Spanish newspaper 'El Mundo' of 26 March 2009. A translation can be found in ESSC Newsletter 2009/3 (Rubio, 2009). If Darwin had been accepted as the founder of geomorphology, instead of Davis with his clever but sterile geological methodology, the discipline would much better fit into the present-day systems approach.

Imeson's study of the geomorphological importance of soil fauna activity expanded in subsequent years to a concerted and comprehensive study of many geomorphological, hydrological (Cammeraat, 1992) and pedological processes (Van den Broek, 1989) in the relatively undisturbed Luxembourg forests. The research was concentrated in the area where the relief is dominated by the Lias cuesta (Figure 2). Although it is tempting to attribute this impressive outcrop to the resistance of the calcite-encrusted Luxembourg Sandstone, this theory is not tenable because the cuesta continues into an area where the calcite is absent and the rock behaves like loose sand. Evidently some form of differential soil erosion must be responsible, but which form? Students started the survey of their catchment by mapping out all mass transfer processes. In the absence of overland flow, the most important process of sediment supply outside the stream valleys is splash erosion. Splash impact is particularly heavy in broad-leaved forests, because rainwater drips from the leaves in large drops. Measurements showed these drops to have diameters of up to 6 mm. When they fall on the ground from the tree crowns which are often over 10 m high, they have reached their theoretical terminal velocity. Splash erosion is confined to areas of exposed mineral soil produced mainly by the burrowing activity of animals. A leading role is played by earth worms, mainly *Lumbricus terrestris* and *Allolobophra longa* (Jungerius *et al.*, 1989). Other agents in control of soil surface exposure include burrowing mammals and stemflow.

We monitored the size of these bare spots on wooded slopes across the escarpment, every year during 10 years to find out if different rates of splash erosion could explain the differences in landscape elevation. The more sand in the soil, the lower the density of worms because they do not like sandy soils. Along the catena across the Lias escarpment this means that splash erosion is minimal on the sandy soils of the Luxembourg Sandstone on top: 0.5%

bare at the end of summer 1980. The fundamental process here is sand splashed from the few bare spots onto the leaves of the surrounding forest floor and subsequently transported downslope stuck to the leaves. This explains the presence of colluvium on forest slopes covered with litter. Conversely, exposed soil is maximal on the clayey soils of the Keuper marls at the base of the escarpment slope: 40% bare at the end of summer 1980.

Several authors presented current denudation rates for small catchments on the forested Keuper marl areas on the lower slopes, obtained using various methods. The most detailed catchment study, the Schrondweilerbaach, showed values of 0.344 t ha^{-1} yr^{-1} for soil erosion on valley slopes including splash detachment, overland flow transport and throughflow (Duysings, 1985). This equals 0.0516 mm of annual soil surface lowering, in the long run equivalent to 51.6 m in 1 million years. To compare this to the lowering of the crest of the escarpment: Van Zon (1980) gave denudation rates for a forested catchment in the Luxembourg Sandstone on top of the scarp slope. Measured denudation after two years was very low, in total only 0.01 t $ha^{-1}yr^{-1}$, which is equivalent to 1.5 m in 1 million years. The experiments in the forests on the Luxembourg sandstone were carried out where the cuesta has a height of 416 m, whereas those at the base had an average height of 310–318 m. This means an altitude difference of ~90–100 m. Thus, worms would need a 'guess-timated' 2 million years to bring about the present relief configuration. This brings us back to the beginning of the Pleistocene.

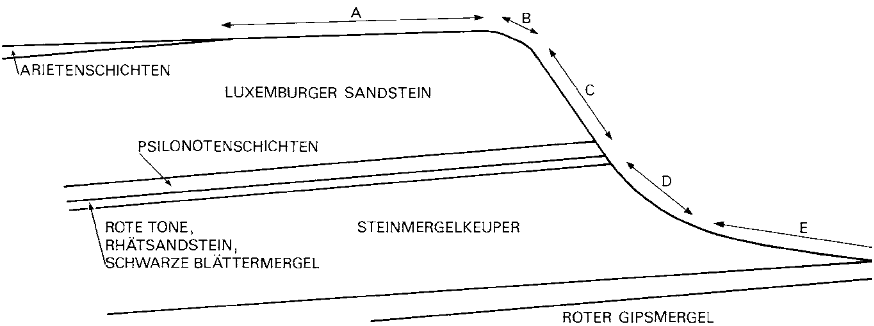

Figure 2. The Lias cuesta in Luxembourg.

Most people cannot help smiling when they are told that the impressive Lias escarpment can be explained by the activity of the tiny worms. That reaction is not surprising: it is a mental quantum leap from two-years of monitoring sediment production by slope processes to extrapolating the results over millions of years. All the more admiration is deserved by Darwin who concluded his experiments with the statement: *"..if a small fraction of the layer of fine earth, 0.2 of an inch in thickness (5 mm), which is annually brought to the surface by worms, is carried away, a great result cannot fail to be produced within a period of time which no geologist considers extremely long".* Or, in the words of our President: *"we can interpret the history of the world through the observation of minuscule processes, that largely pass unnoticed but have the enormous dimension of time to originate major changes".* One thing is obvious, though: conservation measures are not required in these forests.

Soil erosion in dunes

Erosion processes in dunes are much more rapid than in the forests, because the vegetation cover is often incomplete and dune sand is rather mobile. Worms are absent, because they do not like sandy soils. There are two Natura 2000 types with geomorphological/pedological properties in their definition: EU habitat type 2120 *"shifting dunes along the shoreline with Ammophila arenaria: white dunes",* and EU habitat type 2130 *"Fixed coastal dunes with herbaceous vegetation: grey dunes".* Classifying coastal dunes according to the colour of the soil was already practised in the 19th century and is internationally accepted.

White dunes

A key role in soil erosion in the foredunes is played by marram grass. The main geomorphic agent in the white dunes is wind, but vegetation is needed to pile up the sand to actual dunes. There is a whole range of sand catchers, starting with the plants that form ephemeral dunes on the beach, and ending with the plants that construct the foredune ridges, and clearly have the highest conservation value: marram grass (*Ammophila arenaria*) which is part of the definition of this habitat type.

For more than a century, foredunes in The Netherlands have been managed to protect them from wind erosion. The choice of the applied measures reflects the lack of understanding by coastal managers of that time in the geomorphological processes involved.

Figure 3. Healthy marram grass (Ammophila arenaria) on the coast of The Netherlands. Marram grass needs a continuous supply of fresh sand in an open structure to outgrow roots infested with nematodes and fungi.

They interpreted the open structure of a vital stand of marram grass (Figure 3) as a struggle for survival, not realizing that the plant needs a continuous supply of fresh sand to outgrow a root system infested with nematodes and fungi (Van der Putten *et al.,* 1989). This is the reason that the shoots of healthy marram grass stand sufficiently far apart to allow the wind to take up fresh sand in between and deposit it around the shoots after rubbing harmful substances from the grains.

The coastal managers were not aware of the needs of the plant and increased the density of the soil cover by planting extra marram grass shoots in between. This resulted in the marram grass receiving insufficient clean sand and losing its vitality and protective effect. This in turn led to planting more marram grass, which repeated the process. From that time on, planting marram grass was a never-ending necessity. In fact, it was forbidden by law to allow any form of wind erosion, such as blowouts in the dunes, for fear of weakening the strength of the coast.

Grey dunes: the role of water repellency

Lack of understanding of geomorphic processes within coastal dunes was also manifest in the management of grey dunes. A key role in soil erosion processes in grey dunes is played by water repellency (Dekker and Jungerius, 1990). It is generally assumed that wind action is the main geomorphological activity in dunes. This is true in the white dunes, but extensive research has shown that slope wash and rill formation are more effective than wind in the zone of grey dunes. The grey colour of the soils of these dunes is attributed to organic coating around sand grains. Water repellent properties begin to develop soon after the deposition of the dune sand and increases with age. This property makes dry sand impenetrable to water and causes rain water to flow downslope during rain. Rainfall intensity rather than total precipitation amount affects erosion processes in two ways: by supplying the large amount of water needed for the high water:sand ratio in the sand flow, and by providing the high frequency drop impact needed to maintain the hydraulic pressure which keeps the sand flow mobile. The lobes of water-saturated sand are deposited as colluvium on lower slopes (Figure 4). This colluvium contains more moisture and organic material than the original dune sand and is, therefore, coveted by vegetation and specific soil fauna.

Figure 4. Colluvial lobe resulting from rainfall on water repellent dune sand on the coast of The Netherlands.

Water repellence is not limited to mineral grains. It is shown also by filamentous algae, some mosses and other shallow rooting organisms in the grey dunes and has been interpreted as a survival strategy to prevent water from entering the soil and germinate the seeds of higher plant species. It explains the persistency of poor, open vegetation cover in grey dunes. Slope wash has an important geomorphological consequence: the removal of the surface soil exposes the original loose dune sand underneath, which is sensitive to wind erosion. Therefore, new blowouts usually form in upper slope positions (Figure 5). Paradoxically, this means that water erosion is needed to trigger wind erosion.

The spontaneous development of blowouts was not allowed by the authorities in charge of coastal safety as it might weaken the defensive strength of the coastal dunes. Hence, by law every bare spot where sand could be blown away had to be stabilized as a conservation measure, preferentially with marram grass, or with reeds or branches. Around 1975, attitudes to conservation coastal dunes were changing under the realization that existing dune stabilization techniques were fixing dune landscapes, leading to loss of geodiversity and subsequently to loss of biodiversity (see Millington *et al.,* 2009). One of the water boards in charge of coastal defence along the Dutch coast tacitly consented to an illegal experiment to see what suspension of planting marram grass meant for the development of blowouts. The experiment was carried out in the inner dunes where the safety of the country was not directly at stake, and with the instruction to keep it out of sight of the public. After two years of measurements it was clear that it was unmistakably best to let nature have her own way: the blowouts stabilized spontaneously when they had reached a certain length (Jungerius *et al.,* 1981). Repetition of the experiment in other dune terrains confirmed the results. Dune

Figure 5. A blowout developed on the upper slope of a coastal dune of The Netherlands after slope wash removed the protective soil cover.

managers and dune ecologists welcomed this conclusion, but for different reasons: not having to plant marram grass saved dune managers thousands of guilders a year, whereas ecologists were happy because it stimulated the growth of pioneer vegetation in the blowouts, which rejuvenated the dune landscape and increased biodiversity. When it was clear that the safety of the country was not at stake, similar experiments were hesitatingly allowed even in the foredunes along the beach. They had the expected result: the artificial sand dike turned into a natural-looking foredune ridge. It is embarrassing to realize that society could have saved a fortune if the natural system had been left alone right from the time the foredune ridge came into being in the 19th century (Jungerius, 2010). And all because the growing conditions of marram grass had not been investigated! The lesson is clear: before we start to interfere with nature for conservation reasons, we must make sure of nature's own defence mechanisms. Negative feedbacks of natural processes are the rule rather than the exception. Even today that lesson is not understood by everybody!

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Soil erosion and conservation in Greece

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Introduction

Greece is a country with great variation in landforms, altitude, vegetation and parent materials. About 49 % of the surface area is characterized by slopes >10%, whereas only 36% comprises lowlands with slopes <5% (Figure 1). Due to its predominantly steep terrain and adverse bio-climatic conditions, the country is facing considerable soil erosion problems. In the uplands, steep slopes combined with the destruction of natural vegetation (by fire, cultivation and overgrazing) have caused severe soil erosion and in many areas the parent rock is exposed at the surface. A higher susceptibility to erosion was observed mainly in acidic soils formed on Tertiary deposits in Northern Greece. Moreover, erosion risks are increasing due to urbanization and recreational activities (Anthopoulou *et al.,* 2006).

Soil erosion and land degradation largely affects crop production and therefore farmers' income, resulting in massive migration, especially of younger people to the major cities. The decline in local economies and increasing unemployment are problems now faced by the European Union, by economically supporting agricultural areas in an effort to maintain rural populations in environmentally-sensitive areas. However, cultivation of highly degraded land is not economically feasible, leading to land abandonment with adverse consequences for the local economy. Soil erosion resulting from human exploitation of the land has attracted much public and scientific interest.

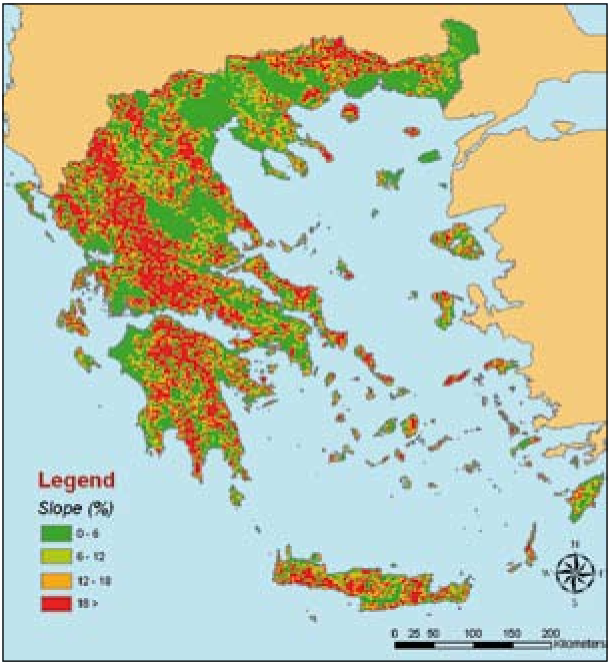

Fig. 1 Map of slope gradients in Greece (compiled by A. Tsitouras, 2010).

Based on soil, climatic and topographic characteristics, land of potentially high quality covers 19% of the total land surface (CORINE, 1992); land of moderate quality 18% and 57% is low quality land. The climate of Greece belongs to the Mediterranean type, with most rains falling in the cool period (October-March), whereas the hottest months (July and August) have very low precipitation. Intense short duration storms are characteristic of the summer dry season. Rain erosivity is highest in the western and south-western parts of the Greek mainland, as well as in the eastern Aegean Islands and especially on the Island of Crete. Lower erosivities occur in the north-west, while the medium erosivity class applies mostly to the central and eastern mainland (Yassoglou and Kosmas, 1988). Soil erosion is one of the most important processes affecting land degradation and desertification in Greece. Declining yields, as a result of soil erosion in the Prefecture of Kilkis (northern Greece) has been observed. The appearance of high erosion risk was observed on slopes >6 % (Haroulis *et al.,* 2002). High erosion rates are mainly attributed to the irregular terrain with steep slopes, relatively shallow soils with poor vegetation cover, high erosivity rainfalls unevenly distributed during the year, and prolonged periods of land mismanagement. Furthermore, large-scale deforestation of semi-arid areas accompanied by intensive cultivation and overgrazing (Plate 1) resulted in accelerated erosion and the formation of extensive lands with very shallow soils. Areas vulnerable to wind erosion include the Aegean Islands and the north-east mainland.

Tillage erosion is one of the most important processes of land degradation in hilly cultivated areas of Greece. The main impacts of soil erosion are the removal of fertile topsoil,

Plate 1. Overgrazing effects on native vegetation (photo by Th. Karyotis).

depleting plant nutrients and fertilizers, reduced crop production, flooding in lowlands, siltation of channels and reservoirs, environmental alterations of wetlands, and decline of the local economies. It was estimated that since the early 1930s, the erosion rate in the sloping agricultural lands of Thessaly has increased to 1.56–2.21 t ha^{-1} yr^{-1} due to intensive irrigation of cotton crops (Kosmas ***et al***., 1996a). As a result of heavy subsidization cotton has become the most lucrative arable crop in Greece. In Central Greece cotton monoculture occupies 80-90% of irrigated farmland, extending even to hillsides with ≥10% slope gradient. Cotton stalks are chopped and ploughed in after autumn harvesting, leaving the soil bare over winter. Large areas of land remain uncovered during winter and early spring, due to late crop establishment and growth. Irrigation with high-pressure guns also causes high soil erosion rates (Plate 2). The high kinetic energy of the applied water impacting on the soil surface disintegrates soil aggregates and detaches soil particles, causing soil crusting and decreased infiltration rates.

The effect of land use and precipitation on annual runoff and sediment loss was investigated in eight different sites along the northern Mediterranean region and the Atlantic coastline located in Portugal, Spain, France, Italy and Greece (Kosmas *et al.,* 1997). Land use greatly affects runoff and soil erosion, with the greatest sediment loss in hilly areas under vines (mean sediment loss 142.8 t km^{-2} yr^{-1}). Areas cultivated with wheat are sensitive to erosion, especially during winter, generating intermediate amounts of runoff and sediment loss (17.6 t km^{-2} yr^{-1}) especially under rainfalls >280 mm per year. Olives grown under semi-natural conditions, as for example with an understory of vegetation of annual plants, greatly restrict soil loss to very low values (0.8 t km^{-2} yr^{-1}). Erosion in shrublands increased with decreasing rainfall to values in the range 280-300 mm and then erosion decreased with decreasing rainfall (mean sediment loss 6.7 t km^{-2} yr^{-1}). Human-induced causes of soil erosion include soil disturbance, removal of vegetative soil cover and/or hedgerows, abandonment of terraces, late sowing of winter cereals and inappropriate use of heavy machinery.

Plate 2. Irrigation causing soil erosion (photo by Th. Karyotis).

Evolution of soil erosion in Greece

Water erosion is a serious problem throughout Europe, especially in the Mediterranean zone, and wind erosion is also common in Central and Western Europe. The European Environmental Agency (EEA, 1995) estimated 115 million ha, or 12 % of Europe's total land area, are affected by water erosion, and that 42 million ha are affected by wind erosion. The Mediterranean region is the most affected, but there is clear evidence that other parts of the EU also suffer significant soil erosion. Archaeological evidence suggests that soil erosion has occurred in extensive areas in Greece for thousands of years, but it has proceeded at higher rates in the last century, following the intensification and mechanization of cultivation. Its hillsides were originally forested (~6000 BC) and covered by a fertile, but shallow, soil vulnerable to erosion. Extensive deforestation has taken place for fuel, house-building, ship construction and other purposes (~4300 BC). Shepherds damaged forests with fire to eradicate woody vegetation and encourage grass growth, which was then overgrazed. Farmers contributed to damage by growing cereals, olives, grapes, fruits and vegetables on sloping ground with insufficient soil protection. Upland grazing (Plate 3) and then farming in Greece probably began around the middle of the second Millennium BC, and it was greatly intensified during the Hellenistic period (800 BC). By the time of the Macedonian hegemony in 338 BC the land had already deteriorated markedly. During the later Hellenistic period, efforts were made to expand agricultural land in Greece by draining wetlands.

Plate 3. Grazing area of Mount Olympus and land abandonment (photo by Th. Karyotis).

Copper and Bronze Age remains have shown that most of the cultivated areas in the islands of the Archipelago were being exploited by the 2nd Millennium BC. Farming with vines, olives, and cereals had been established on the islands and particularly on Crete. Pressure on land resources resulted in the construction of agricultural terraces in Minoan Crete. Several artificial terraces to protect against soil erosion on Delos Island, an economic centre of Greek antiquity, must have been constructed before 400 BC. Many hillside terraces on Crete, which are dated to the 16th century, were used for vines and cereals, the latter being displaced by vineyards (Grove, 1996).

Current situation

Soil erosion in Greece has proceeded at high rates in the last 50 years following the intensification and mechanization of cultivation. One of the most spectacular examples of severe soil erosion is the removal of the surface soil horizon that occurred in the hilly Tertiary landscapes of central Greece at rates >1 cm yr^{-1}(Danalatos, 1993). Erosion processes mainly responsible for land degradation in Greece are related to water, wind and tillage erosion. Water erosion constitutes a major land degradation problem in the hilly areas. Soil erosion is attributed to climatic conditions, vegetation cover and land use management practises. The large scale deforestation of hilly areas in recent decades, accompanied by intense cultivation and overgrazing, resulted in accelerated erosion and the formation of badlands with very shallow soils.

Soil erosion results in severe losses in the productivity of soil resources and affects the quality of life in various parts of Greece. This phenomenon has become a serious threat to the welfare of people in many areas of Greece, because large areas are seriously affected. The evolution of erosion is developing slowly and attention should be given to possible changes in related soci0-economic factors. Man affects erosion by excessive harvesting of plant biomass and cultivation practises on slopes, leaving soil surfaces uncovered during rainfall. The soil properties which affect the stability of soil aggregates (size 2.0–4.7 mm) include the cation exchange capacity (CEC) and the total specific surface area (Dimoyiannis *et al.,* 2001). As these two parameters increase, aggregate stability increases. In turn, these parameters depend on the percentage and species of clay minerals. Calcium carbonate also increases aggregate stability.

Drier microclimatic conditions reduce the potential for plant growth and the soils remain bare for long periods, favouring overland flow and erosion. The soils on many hilly areas are very shallow or the parent rock is exposed at the surface. Soil textures on acid rocks are usually moderately coarse to medium and soil aggregate stability is low. Therefore, soil erodibility on these parent materials is high and soil erosion has proceeded over large areas. It is estimated that ~28 % of the country's land surface is partly degraded due to the presence of such parent materials. Hilly areas with a substratum of shales/sandstones or flysch exhibit less erosion risk. The soils are moderate to fine-textured and permeable, and have a moderate to rich vegetation cover. However, if the natural vegetation is removed (i.e. by fires or forest clearance), the areas on flysch become very susceptible to gully erosion and landslides.

Apart from the rain that comes into contact with any soil surface and causes, under certain circumstances, the breakdown of soil aggregates, soil management contributes to a substantial increase in clay loss. Since clay is one of the most important soil constituents, soil quality and soil productivity are permanently damaged. With decreased clay content, the soil becomes more erodible (Zhang *et al.,* 2004; Terzudi *et al.,* 2006).

The Action Plans to decrease nitrates in Greece and Codes for Good Agricultural Practises have been drafted to satisfy the demands for environmental protection and assure compatibility with the Common Agricultural Policy (Karyotis *et al.,* 1999, 2006). These Codes affect a wide spectrum of agricultural and husbandry activities and specialized cases, such as measures against erosion risk. These cases are areas or zones subjected to specific local policies. These include: plant cover on slopes >10 %, strip rotation along contours (with legumes alternating with other annual crops), minimum ploughing, ploughing along contours in fields with slopes >10%, alternating cultivation and fallow strips, use of non-soil eroding irrigation systems on sloping land, reduction in grazing density, prohibition of burning of crop residues on soils with slopes >10% and prohibition of deep ploughing at >40 cm depth (unless there is a need to break long root weeds or impervious soil horizons).

Erosion was measured on various land use types (cereals, vines, olives, bare land and shrubby vegetation) and showed erosion strongly depends on vegetation type. Erosion rates in the hilly areas in central and northern Greece ranged from 0–52 t km^{-2} yr^{-1} (Kosmas *et al.,* 1996b; Stamou, 1995). Similarly, soil erosion rates measured in vineyards in the Attica area ranged from 15-252 t km^{-2} yr^{-1} (Kosmas *et al.,* 1996b). The lowest rates of runoff and sediment loss usually occur in olive groves (Plate 4) under semi-natural conditions and certain types of management. This includes maintaining annual vegetation cover, which combined with the dense leaf canopy of trees, efficiently protect the soil surface from raindrop impact and so runoff and sediment loss is negligible. Soil erosion data taken from experiments conducted in Spata (Attica) are presented in Table 1 (Kosmas *et al.,* 1996b).

Plate 4. Olive groves in the Island of Evia after fires (photo by C. Kosmas).

Table 1. Erosion rates measured on runoff plots on Calcic Xerochrepts in different land uses

Spata experimental field site (number of plots = 35)														
Year	**1st**		**2nd**		**3rd**		**4th**		**5th**		**6th**		**7th**	
	R	SL	R	SL	R	SL	R	SL	R	SL	R	SL	R	SL
Olives	472	2.8	339	0	402	0	799	0.1	292	0	302	0.2	307	0.3
Vines		10.0		0		1.2		19.1		11.9		24.5		4.2
(R = annual rainfall (mm), SL = soil loss t ha^{-1} yr^{-1}, plot size 10^3 m, slope 7–23%).														

In shrub lands which are used mainly for grazing, soil erosion rates depend on annual rainfall, vegetation cover and livestock density. Erosion rates measured on Zakynthos Island ranged from 0.2–1.6 t km^{-2} yr^{-1}, while higher erosion rates are expected in eastern Greece (Kosmas *et al.,* 1996b). Soil depth and type of parent material affect vegetation cover and erosion rates in shrublands. Long-term studies in various shrublands and abandoned lands of Greece showed that two classes of soil depth may be distinguished for land protection strategies: (a) a critical soil depth (25–30 cm), below which the recovery of the natural vegetation is very low, and erosional processes may be very active, resulting in accelerated soil erosion rates; and (b) a crucial soil depth (4–10 cm) under which perennial vegetation cannot be sustained, the soil is rapidly removed by wind or water erosion, and thus land degradation is irreversible (Kosmas *et al.*, 1996b).

Tillage erosion is one of the most important processes of land degradation in cultivated hilly areas in Greece. Extensive areas have largely degraded during recent decades due to erosion (Figure 2) caused by several factors, amongst them the use of heavy machinery in cases of deep ploughing at high speeds in directions usually perpendicular to the contour. This resulted in the displacement of much soil from upper convex hillslope to lower concave

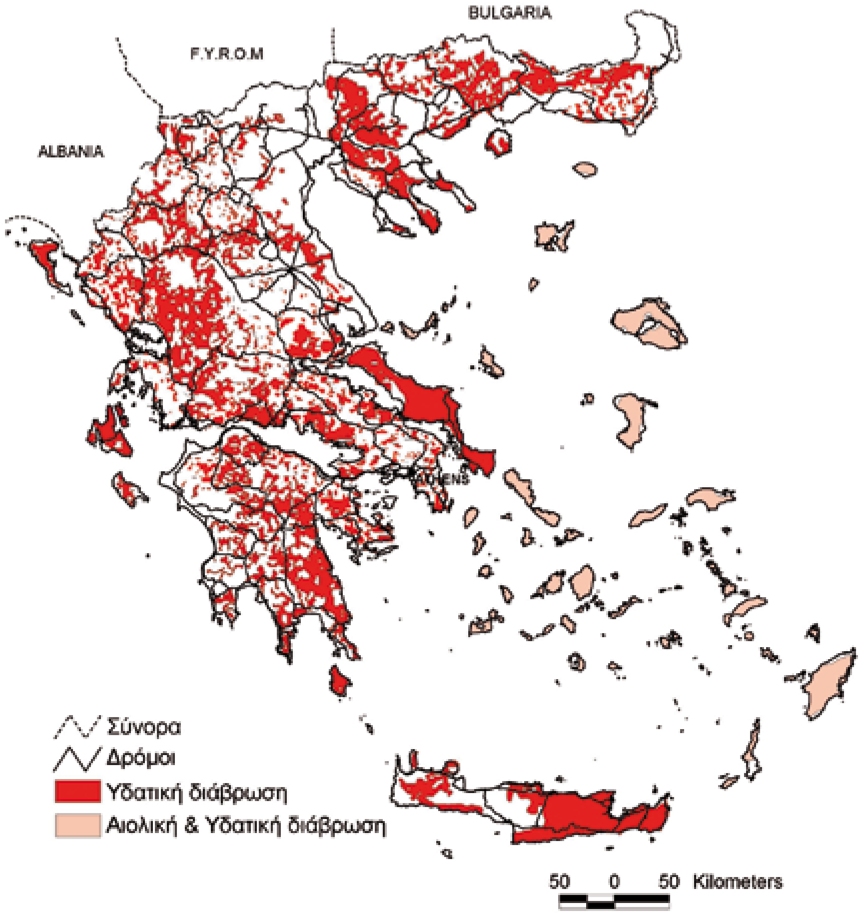

Figure 2. Hot spots' in Greece for water and wind erosion (translation of Greek captions: borders (dashed line), roads (full line), water erosion (red) and wind erosion (pink).

footslopes. This significantly decreased crop productivity on the convex positions, especially when subsurface limiting soil layers occur (such as petrocalcic horizons or bedrock). It is estimated that 8% of the hilly agricultural land in Greece has been abandoned in recent decades due to diminished productivity caused by soil erosion (Kosmas, 1999).

Tillage erosion exposes subsoil, which may be highly erodible by wind and/or water. Studies based on: (a) the comparison of preserved areas with neighbouring cultivated ones in Thessaly (central Greece), (b) previous records of soil characteristics (Papoutsopoulos and Zvorykin, 1936), and (c) soil erosion data obtained under agricultural management practises and similar land conditions (Tsara, 2001), clearly demonstrated that tillage rather than water erosion is the most important factor controlling land degradation in hilly cultivated areas. Water erosion in areas cultivated with cereals, vines or olives is responsible for the loss of ≤1-3 mm of soil per year (Kosmas *et al.,* 1996b). The estimated total annual soil loss in the same areas cultivated mainly with cereals reaches 4–14 mm per year (Kosmas *et al.,* 2000). Soil studies in Thessaly hilly areas showed that soil depth has been reduced by 24–30 cm in the period 1936–1999. Measurements conducted in hilly areas in Greece to assess tillage erosion under existing management practises have shown that soil displacement is greatly affected by plough depth, tillage direction and slope gradient (Kosmas *et al.,* 2001; Gerontidis *et al.,* 2001). On steep hillslopes, a maximum soil displacement of 97 cm was measured in the plough layer after ploughing the soil down-slope to 40 cm depth and perpendicular to the contour. Under the same soil conditions and management practise, soil displacement decreased to 69 cm after ploughing the soil along the contour. A 50 % reduction in plough depth can reduce soil displacement by >75 %.

Wind erosion is another process of erosion and information on the extent of this problem in Greece is limited. Areas vulnerable to wind erosion include the Aegean Islands and the north-east mainland. Strong northerly or north-easterly winds prevail during the dry period in Greece, creating favourable conditions for wind erosion. The main factors controlling wind erosion in Greece are vegetation cover, slope exposure, soil water deficit, grazing and fires. Under dry conditions, perennial vegetation cannot grow, and only annual vegetation is present during the wet period. If the land is grazed, soils are only partially covered during the summer period, favouring conditions for wind erosion. Fires destroy the existing vegetative cover and contribute to wind erosion by exposing the soil surface to wind action. The highest wind erosion rates in Greece are expected on north and north-east facing slopes. Winds are predominantly southerly during the wet period, when the soils are usually protected by vegetative cover. Therefore, southern and south-western exposures are less affected by wind erosion. Soil water deficits, which usually occur during summer and early autumn, create favourable conditions for soil particle detachment and wind erosion. Animal pathways are also vulnerable to wind erosion. Animal trampling in certain pathways destroys soil aggregate structure, leaving a layer of dust which is easily deflated.

Soil organic matter (SOM) plays a dominant role in soil aggregate stability and so strongly affects soil loss by water erosion. SOM and clay particles form stable soil aggregates whose stability determines soil erodibility. Numerous field and laboratory studies have shown that soils with low SOM contents are more erodible (Plate 5) than organic soils, and generally soils with <2 % SOM content by weight are highly erodible (Fullen and Catt, 2004). Soil detachment by raindrop impact decreased with increasing SOM in the range 0–12 % (Ekwue, 1990). The role of SOM depends considerably on its origin and maintaining SOM in mineral soils is one of the current challenges in agriculture. However, wind and water erosion processes may lead to the transfer of pollutants when exogenous organic matter is applied. Hence, certain sources of organic matter (especially sewage sludges and biowaste composts) should not be applied to soils at risk of erosion (wind or water), or in areas in the immediate vicinity of sensitive environments, so as to minimize the risk of contamination of air and surface and ground-waters (Owens, 2004).

Plate 5. Highly erodible material on the Island of Crete (photo by C. Kosmas).

Analytical data on topsoil SOM contents of hilly lands in Central Greece (Thessaly) have shown a reduction from 2.6% to 1.5% during the last six decades. This is mainly attributed to management practises, such as oxidation due to ploughing, burning of plant residues and loss due to water erosion. The removal of organic matter reduces soil aggregate stability and thus increases soil erosion. In Greece, scientific concerns have been expressed about the decline in soil organic carbon (SOC) levels in arable soils in recent decades and loss of SOM was attributed to increased cultivation intensity. SOC content in the arable land of Greece was estimated in the intensively cultivated area within a range of altitude between 0–300 m above sea-level (Th. Karyotis and A. Tsitouras, 2010; unpublished data). Over 5,200 surface samples across Greece were used and SOC content was divided into four classes (Table 2, Figure 3). The lower SOC content can be attributed to low residue inputs to soil, as a high percentage of dry matter is removed in harvested organic material. Burning continues to be a predominant residue management practise, particularly in Central Greece. The impact of straw management on the SOC content of Greek arable soils is uncertain. In intensively cultivated soils, changes can vary depending on climatic conditions, soil type and tillage practises. Irrigated crops produce substantially higher yields, but in Greece it is not known how much C levels are altered in irrigated arable soils. Effects of fertilization practices on SOC levels in Greek arable soils have not been determined experimentally. The mean values of SOC content within four classes of topsoil (0-30 cm depth) varied and ranged between 0.68–8.09 %. Differences can be attributed mainly to soil stratification, soil development factors and anthropogenic activities.

Table 2 Soil Organic Carbon (SOC) in surface arable horizons (0–30 cm) in Greece

SOC Classes (%)	Arable area (ha)	%	OC (t/ha)	SD	%CV
0–1	1,935,242.1	49.5	26,8301	0.1988	29.1
1–2	1,821,679.1	46.6	48,9450	0.2460	18.8
2–5	119,722.9	3.1	88,5570	0.5906	22.6
>5	31,726.5	0.8	221,0672	2.9081	35.9
	3,908,370.6	100.0			

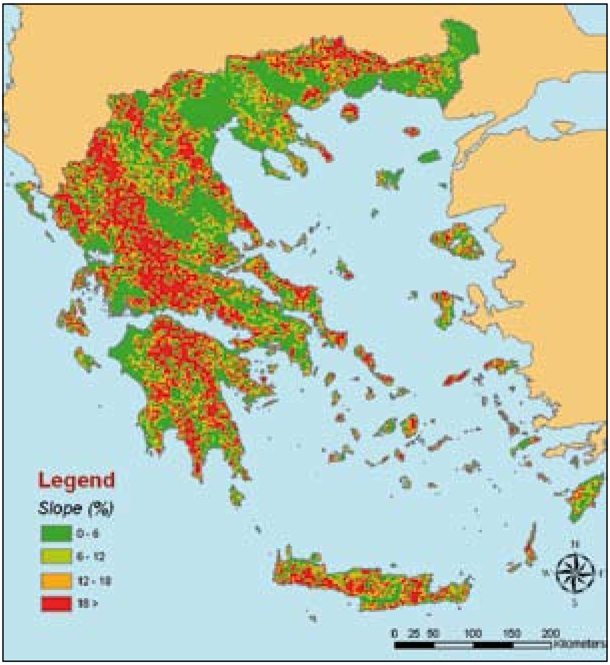

Figure 3. Soil organic carbon contents in Greek arable soils (source: Th. Karyotis and A. Tsitouras, 2010).

Soil erosion caused by water can remove large amounts of N- and P-fertilizers, especially when applied to the soil surface. Traditionally, fertilization of vines, olives, cereals and almonds is achieved by spreading mixed fertilizers to the soil surface during winter. Under such conditions, large amounts of nutrients can be transported to surface waters, causing pollution problems and the eutrophication of lakes and reservoirs. Measurements of nitrogen loss by runoff water, which have been conducted in vineyards in the Attica area, have shown losses of ≤9.5 kg N ha^{-1} yr^{-1}.

Redistribution of topsoil from upper landscape positions by the various tillage operations significantly reduces effective soil depth and water holding capacity, which is the most serious loss in the long-term, restricting crop productivity (Danalatos, 1993; Kosmas *et al.,* 1993). Studies in various hilly areas have shown a drastic decreases in cereal production in upper hillslope positions, accompanied by slight increases in crop productivity in lower locations.

Wild-fires are one of the more severe disturbances for natural ecosystems in the Mediterranean basin and can become a critical factor in soil erosion processes. Burned forests in dry areas with shallow soils are not easily regenerated and therefore they slowly disappear. In August 2006, a large wild-fire on the Kassandra Peninsula of northern Greece burned one-fifth of the Peninsula. After the fire, in order to protect the soil from erosion, the Forest Service applied a hill-slope rehabilitation treatment of contour-felled logs and branch piles. The coupling of the Universal Soil Loss Equation and GIS was implemented and the erosion potential was estimated at 2.8 t/ha/year pre-fire, 29.5 t/ha/year post-fire, and 21.3 t/ha/year after rehabilitation treatment (Myronidis *et al.,* 2009). Off-site effects can be either short- or medium- to long term, such as damage to crops and infrastructure from uncontrolled runoff and flooding, siltation of channels and reservoirs, environmental alterations of wetlands, lakes and estuaries, decline of the economy of local communities, and migration of local people. Extensive agricultural lowlands are frequently flooded by water that destroys crops.

Siltation of water channels is very important in catchments having steep slopes and poor vegetation cover. For example, the rivers Sperchios (central Greece) and Evrotas (southern Greece) transport huge amounts of sediment every year, which are deposited in alluvial plains. Torrent creeks, originating from catchments with low vegetation cover and shallow soils formed mainly on igneous rocks, contribute large amounts of boulders, coarse gravel and sand each year, thus aggravating flooding problems. Measurements in western Greece, where flysch formations are predominant, and in several sites in eastern Greece, showed that the sediment load transported to dams ranged between 1,200–2,000 t km^{-2} yr^{-1} (Zarris *et al.,* 2002).

Soil erosion rates in Central Greece were 5.23 kg ha^{-1} for wheat lands, 1.89 kg ha^{-1} for fallow land and 2.77 kg ha^{-1} for herbicide treated land (Theocharopoulos ***et al.,*** 2006). Based on ^{137}Cs residuals, erosion rates were estimated to vary from 3.54–95.78 t ha^{-1} y^{-1}, while deposition rates ranged from 1.23-189.18 t ha^{-1} y^{-1}.

Measures and policies to mitigate erosion

The mitigation of erosion can be achieved by proper techniques and land management practises. Potential actions include:

- Long-term set-aside of agricultural land.
- Afforestation of agricultural land.
- Conservation and reconstruction of terraces on sloping areas.
- Definition and revision of 'Codes of Good Agricultural Practise.'
- A forest operational plan should be implemented, including the restoration of burnt forests, nurseries, protection from forest fires, national parks, improvement of degraded forests, mapping and planning of forest land, studies and research.

It can be argued that preventive measures and practises may be based on: implementation of a policy of subsidies which encourage farmers to rotate or set-aside marginal areas, incentives for afforestation, minimum ploughing and/or ploughing along contours, application of rational irrigation by means of the extension of drip-irrigation systems, not burning plant residues after harvesting and general adoption of sustainable land use planning. However, there is insufficient public investment to combat erosion in agriculture and this is not a priority action for Greece. Measures to protect the soil should focus on the main processes which threaten conservation and maintain the soil as a non-renewable natural resource (Martínez-Fernández, 2003). Moreover, the following general measures to prevent erosion should be taken into consideration:

- A combination of reduced tillage, cover crops and contour tillage can decrease soil loss to the annual tolerance rate.
- Winter cover crop is an essential tool to decrease erosion, when ploughing is unavoidable.
- Conventional tillage leads to higher clay loss than reduced tillage with heavy cultivators and disk harrows, thus causing higher soil fertility damage.

Legal and institutional measures are also needed to minimize erosion risk, such as:

- Immediate banning of grazing in burnt forests, as well as artificial reforestation in areas where natural recovery is not possible.
- Socio-economic incentives for sustainable development in eroded areas.
- Incentives for the restoration of terraces, wherever this is economically feasible.

Effective erosion control measures related to cultivation are those which ensure vegetative cover of agricultural land. These could include:

- Application of subsidised set-aside systems, with priority to sloping areas.
- All steep slope areas should be converted to forests or pasture land.
- Tillage and land management practises strongly affect soil erosion problems. Tillage systems should maintain some residue cover on the soil surface. Plant residues reduce soil compaction from raindrops, thus preventing soil sealing.
- Contour orchards may reduce erosion and sediment yield. Contouring allows better access to rills, permitting maintenance that minimizes additional erosion.
- Planting trees, shrubs, vines, grasses or legumes on highly erodible areas may reduce soil erosion and sediment delivery to surface waters. Plants may take up more of the nutrients in the soil, reducing the amount leached into ground-water or washed into surface waters.
- Late seed bed preparation should aim to reduce soil erosion by maintaining soil cover as long as practical to minimize raindrop effects and runoff.
- The practise of terracing (when it is economically feasible) can reduce slope length and surface runoff. Terraces may have detrimental effects on water quality if they concentrate and accelerate delivery of dissolved or suspended nutrients, salts and pesticide pollutants to surface or ground-waters.

According to the European's Commission proposal (COM2006, 232) to establish a framework for the protection of soil, a targeted and efficient soil protection policy should be based on accurate knowledge of where degradation is occurring. It is recognized that certain degradation processes, including erosion, occur in specific areas and this requires the identification of these risk areas. The Commission's Communication to the European Parliament and the Council 'Towards a Thematic Strategy on Soil Protection' identifies the main soil degradation processes which confront the EU. To ensure a coherent and comparable approach in the different Member States, identification of risk areas should be based on a common methodology, which includes elements known to be driving forces for the various degradation processes.

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Soil Erosion Control through the Use of Grass Vegetative Filter Strips in the Western Indian Himalayan Region

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Plate 1. Vegetative barrier of Guinea grass (Panicum maximum).

Introduction

In the Indian Western Himalayan region, agricultural activities are mostly carried out on hillslopes where erosion losses are very high. Although bunding is an effective soil and water conservation measure, but it is expensive and requires frequent maintenance. Hence, vegetative barriers comprising of permanent strips of closely-spaced grasses grown on contours are effective as an alternative to bunding (Plates 1 and 2). Vegetative barrier technology is practised on gently sloping land ranging from 2–8 % in the lower Doon Valley (30^{o}20´40´´N, 77^{o}52´12´´E; 516.5 m above sea-level). For vegetative barriers, economically important grasses that give dense and perennial cover should be selected. Grasses such as Guinea grass (*Panicum maximum*), Khus khus (*Vetiveria zizanioides*) and Bhabar (*Eulaliopsis binata*) have been found suitable for this purpose in the Shivaliks and Lower Indian western Himalayan region. Vegetative barriers are beneficial in reducing sheet and rill erosion, ephemeral gully erosion, managing water flow, stabilizing steep slopes and trapping sediment. Furthermore, they provide other products, such as fodder and green manure.

Why use guinea, khus khus and bhabar grasses as vegetative barriers?

These three species are used as barriers for effective erosion and sediment control because they form erect, stiff and uniformly dense hedges, and so resist overland flow. They also have roots which bind soil and thus prevent rilling and scouring near the barrier. The grasses can survive moisture and nutrient stress and re-establish top-growth quickly after rain. They cause minimum loss of crop yield and will not proliferate as a weed, nor compete for moisture, nutrients or light. The grasses do not act as hosts for pests or diseases and supply products of economic value to farmers. Besides this, guinea grass is nutritious, palatable and free from oxalates. The crude protein and the crude fibre content of this grass varies from 8-14 % and 28–36 %, respectively. Khus khus is also used for handicrafts, roof thatch, mushroom growing, animal fodder, feed stuff and herbs. Bhabar grass is used for rope, string and mats and young shoots are used as fodder.

Technology development

The vegetative barrier technology was developed for gentle slopes ranging from 2-8% in the north-western Indian Himalayan region using the grass species guinea, khus khus and bhabar. Slips of these species are planted along the contour with 75 cm paired-row distance along with 20 × 20 cm plant-to-plant spacing in a 10 cm wide furrow of 20 cm depth in a staggered fashion on a 1 m vertical interval. This corresponds to 50, 25 and 12.5 m horizontal intervals on 2, 4 and 8 % slopes, respectively, on 100 m length slope segments. The excavated soil of the furrow is kept downslope of grass barriers. This technology is 10% cheaper than earth bunding. Farmers can adopt any of these as vegetative barrier strategies. Adoption largely depends on the availability of the specific grass species.

How do vegetative barriers work?

Water flow is impeded and so silt carried along with it is deposited near the barrier (Figure 1). Sediment deposition and tillage operations progressively cause benching.

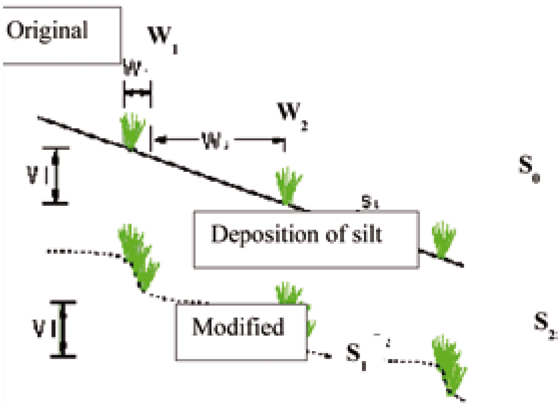

Figure 1. Reduction in slope and plant growth through forming a natural terrace.

W1 = design width of barriers, W2 = designed width of cropped strips, S0 = original land slope steepness, S1 = future barrier backslope steepness, S2 = future steepness of cropped interval, V1 = Vertical interval between barrier.

Technology implementation

Soil and climate

All the grasses thrive in a warm (temperature 15–38 °C) moist climate and can grow from sea-level to 1800 m altitude. The three grasses are adapted to a wide range of soils. They usually grow well on well-drained light textured soil, preferably sandy loams or loams, but cannot tolerate heavy clays or continuously water-logged conditions.

Plate 2. Vegetative barrier of Bhabar grass.

Field preparation

The three grasses do not require special land preparation. They can be planted in maize fields, where two or three ploughings and one leveling are sufficient. Land should be free from weeds and fertilizer application is the same as that for maize.

Planting materials

Seeds and slips can be used as planting material. To obtain slips for planting, old clumps are uprooted and slips with roots are separated. Uprooting and planting of root slips should be completed in the same day. For quick establishment, root slips of grasses are preferred over seed. Root slips of grasses should be collected from existing plant material from nearby places or from authentic sources. One clump (3–4 years old) provides 3-5 root slips. About 2000–3000 root slips are required for planting a paired row (row-to-row distance 75 cm and plant-to-plant 20 cm) for 100 m running length of a barrier which requires 4,000–6,000; 8,000–12,000 and 16,000–24,000 root slips per ha for 2, 4 and 8 % slopes, respectively. Row-to-row spacing of 75 cm and plant-to-plant spacing of 20 cm is recommended for all grasses (Table 1).

Protocol for planting and timing

- Demarcation of contour line and slopes.
- Identification of 1 m vertical interval, which is 50, 25 and 12.5 m horizontal distance on 2, 4 and 8% slopes, respectively, in a 100 m length plot (Table 2).
- Opening of furrow (10 cm wide and 20 cm deep) along the contour in a paired row at a distance of 75 cm, prepared using a country plough or other small agricultural implements in the respective horizontal distance.
- Root slips containing 2-3 tillers are planted in furrows in a paired row. For accommodating a paired row of vegetative barriers, planting is performed in a staggered fashion. Planting is done during the first to second week of July for all the grasses.

- The soil excavated from contour furrows is heaped on the down-slope side to form a bund.
- Watering may be done with the help of bucket to promote better soil binding with root slips.

Table 1. Recommended plant species with their spacing between plants and rows for vegetative barriers

Grass	Spacings (cm) between:		Plantings materials*	Total planting materials (000/ha) on slopes of:		
	Row-to- row	Plant- -to- plant	Nos.	2%	4%	8%
Guinea grass	75×75	20×20	1000–1500	4-6	8–12	16–24
Khus khus	75×75	20×20	1000–1500	4-6	8–12	16–24
Bhabar	75×75	20×20	1000–1500	4-6	8–12	16–24
*Per 100 m length of single row.						

Calculation of number of barriers and distance between them:

1. Length and slope of the field should be measured.
2. Horizontal (surface) distance between the barriers =

$$\frac{\text{Length of the field (m)}}{\text{Slope (\%)}}$$

For example, if the length of the field is 100 m and the slope is 2%, then the horizontal distance of the barriers will be 50 m.

3. Number of barriers = $\dfrac{\text{Length of sloping field (m)}}{\text{Horizontal (surface) distance between two barriers (m)}}$

Table 2. Suggested surface distance between barriers based on slope of the field and number of paired rows on different slopes in a 100 m length field

Slope (%)	Horizontal (surface) distance between barriers (m)	
	Vertical interval (VI) = 1.0 m	**No. of paired rows**
2	50	2
4	25	4
8	12.5	8

Cost of planting barrier

The cost of the barriers is € 41/ha, € 83/ha and €167/ha on 2, 4 and 8 % slopes, respectively, compared with € 91/ha for contour bunding, irrespective of slope (Table 3).

Table 3 Cost of planting barriers

Components	Slope (%)		
	2	4	8
Cost of planting material @ €0.005-0.008/slip	33.61	67.23	100.84
Cost of labour for opening furrow and planting (lump sum)	4.03	8.07	16.13
Cost of gap filling and maintence (lump sum)	4.03	8.07	16.13
Total (€/ha)	41.68	83.36	166.72
(Note: based on € 1 = 59.50 Indian Rupees (Rs.) on 25/11/2010).			

Protocol for the maintenance of barriers

- Gap filling is required after the first planting until the complete barriers are established.
- All grass species require at least two cuts per year. First, just before the onset of the monsoon in May/June and second in October/November to encourage tillering.
- For an effective live barrier, annual trimming to 15–30 cm height annually along with hoeing in between rows with every cut is recommended. Other shrubs and grasses should be periodically removed.

Table 4. Effect of three grass barriers on grass yield, maize yield, runoff and soil loss on different slopes (2–8 %) at Dehradun

Parameter	2%	4%			8%	
	Guinea grass	Guinea grass	Khus khus	*Bhabar*	Guinea grass	Khus khus
Water loss (% of rain)	25.8	33.3	35.1	37.9	38.90	40.52
Soil loss ($t\ ha^{-1}\ yr^{-1}$)	3.27	6.12	6.72	8.34	9.45	9.87
Grain yield of maize ($kg\ ha^{-1}$)	2530*	2460	2444	2296	2285	2180
Grain yield of wheat after maize ($kg\ ha^{-1}$)	2852*	2693	2555	2362	2415	2385
Dry grass yield ($kg\ ha^{-1} yr^{-1}$)	1675	1540	542	1090	1375	485
*Equivalent yield.						

Benefits and economic considerations

Benefits of vegetative barriers become evident after three-to-four years of planting, in addition to the less tangible benefits from conservation measures. Generally, vegetative barriers can reduce runoff and soil loss by 18-21% and 23–68 %, respectively, on slopes varying from 2–8%. Maize and wheat yield increases by ~23–40 % and 10–20 %, respectively, due to conserved moisture (Table 4). In addition, ~0.54–1.67 t ha^{-1} yr^{-1} dry grass yield is obtained as fodder from the barrier. The return from grass species varies from €12.60–14.28 ha^{-1} yr^{-1} as biomass. The net return with crop rotation of maize-wheat with the adoption of vegetative barriers varies from € 101–360 ha^{-1} yr^{-1} on different slopes (Table 5). The additional benefit of € 135, 95 and 52 $ha^{-1}yr^{-1}$ on 2, 4 and 8 % slopes, respectively, have been realized by adopting vegetative barriers over traditional practises on sloping land. Guinea grass and Khus khus grass are more effective than Bhabar in reducing erosion and soil deposition. On-site fodder availability, particularly during the winter season, is an additional advantage without sacrificing the yields of maize or wheat crops.

Table 5. Effect of vegetative barrier on mean yield of crops and net return on different (2–8 %) slopes at Dehradun

Slope (%)	Practise	Crop yield (kg/ha)		Cost of cultivation (€/ha)	Gross Returns (€/ha)	Net returns (€/ha)
		Maize	wheat			
2	Without vegetative barrier	1956	2396	512.61	737.56	224.96
	With vegetative barrier	2530	2852	554.29	914.20	359.92
4	Without vegetative barrier	1632	2283	512.61	675.46	162.86
	With vegetative barrier	2400	2537	595.97	832.13	236.17
8	Without vegetative barrier	1305	1914	512.61	564.17	51.54
	With vegetative barrier	2232	2400	679.53	783.43	104.10

Advice to farmers

- Planting materials should be procured well in advance from a nearby locality.
- The designed field layout should be in place before the onset of the summer monsoon rains.
- To reduce the material costs of vegetative barrier, farmers may plant 100 m running length (one line) in the first year by just spending € 0.17. Once it is established, the cost of root slips will be zero in successive years. In this way vegetative barriers are much cheaper than contour bunding.
- For fodder purposes, guinea and bhabar grasses are recommended rather than Khus khus.

Conclusions

There is strong evidence that all three grasses meet the requirements of a long-term, low-cost vegetative technology for soil and moisture conservation. The vegetative barrier technology is applicable on slopes ranging from 2–8% in the high rainfall zone of the north-west Himalayan States (Uttarakhand, Himachal Pradesh, and Jammu and Kashmir), specifically the Shivaliks and Lower Himalayan region. It is inexpensive and appropriate for both large and small-scale farming operations.

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The Newsletter and supporting Ph.D. research

Editor's note:

At the ESSC Council meeting in Lleida (Spain) in September 2006, the interactions between the ESSC and younger soil scientists were discussed (see Newsletter 2006/3, p. 5-8). It was decided that the ESSC should be more proactive in its support of younger scientists. As part of that initiative, we welcome articles from both Ph.D. researchers and supervisors. We would like to hear from recent Ph.D. graduates; what advice and experience do you have which you would like to share with your colleagues in earlier stages of their research? We would also like to hear from current Ph.D. researchers; what are the factors which both encourage and limit progress? What are the particular challenges facing part-time Ph.D. researchers? We also invite contributions from experienced Ph.D. supervisors. What experience would you like to share with less experienced colleagues? If you are a less experienced Ph.D. supervisor, what supervisory issues do you find challenging? In short, please tell us "what I know now, which I wish I knew then!"

Below is a commentary on the Ph.D. process from Jennifer Millington (Ph.D., 2010).

Editor's note:

The citation details of Ph.D. theses by ESSC members since and including 2004 have been added as an additional page to the ESSC web site. To date, 50 Ph.D. theses are quoted. On the ESSC web site, please look under 'Publications.' Please forward the citation details of any additional Ph.D. thesis completed since the year 2000 by an ESSC member to any of the Editorial team. We will then add the thesis citation details to the web site.

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Jennifer Anne Millington (2010). Pedogenesis on the Sefton coastal dunes, north-west England. Ph.D. thesis, The University of Wolverhampton (UK), 375 pp. (Abstract presented in ESSC Newsletter 2010/4).

I can remember the feelings I had when I first started my Ph.D. They were a combination of excitement and eagerness, alongside absolute fear! *"Just how am I going to be able to do this?"* It is true that at the beginning of my research I did not have a clue about how I was going to produce so much work in three years, a relatively short period of time, and how it was going to turn out. But, as I became more involved in my research, the challenges and intellectual satisfaction motivated me to carry on and to want to find out more. The best thing I did was to create a 'to do' list/table, with proposed deadlines, which I ended up having to add to and modify at pretty much every stage of my research. It was so reassuring to see my work timetable planned out in a simplified format. However, it was very difficult to stick to these deadlines and so I began to only treat them as a guide. Unexpected problems did arise, such as bad weather and unavailable laboratory equipment, but by being organized and monitoring my progress on the 'to do' list, it was possible to overcome any such hurdles. Doing a Ph.D. involves a lot of thinking and inspiration, which is something that you cannot turn on and off. Sometimes I would wake up in the middle of the night with an idea that had to be written down immediately. Other times, I would go for two or three days and feel like I had not achieved anything.

I think it is important to start writing your literature review straight away, purely to gradually learn academic style. I found that I did not include some of my earlier writing, or if I did I rewrote it, as I found that my writing skills improved vastly over the three years. Every time I cited something interesting, I would update my list of references, therefore saving a lot time through not having to compile the dreaded reference list at the end! I found it especially useful to keep all of my field, laboratory and general notes in consecutive hardback notebooks, making sure that everything was labelled and dated. I was very fortunate in that I already had experience of the laboratory techniques proposed for my research. However, it did take a little time to re-educate myself on the methodologies. The Midlands Consortium was very useful for introducing the laboratory techniques that are available at other Universities in the Midlands of England and for networking and developing useful contacts. It was also a great opportunity to get over that initial presentation in a friendly, supportive environment.

Attending conferences enhanced my networking skills further within the wider research community, while publishing conference proceedings and papers also gave me sound academic writing experience. Initially, I misunderstood the fact that most papers are written in the straightforward format of:

i) A review of the subject area.
ii) Asking the research question.

iii) Presentation of methodologies.
iv) Data collection.
v) Data analysis, and
vi) Discussing the results.

At first, I expected the writing of my thesis to be just as straightforward. However, my research certainly was not so clear-cut. At various points I found myself having to rethink my methodologies, go back to collect more data or ask other research questions. Regular meetings with my supervisors kept my research focus, preventing me from going off on a tangent. From the beginning I tried not to be put-off by my returned chapters being covered in red ink! Instead, I tried to think of it as a positive response, as the more input I got in terms of writing techniques, the more I found myself developing. And sometimes, I just did not get the results that I wanted! However, my supervisors reassured me that negative results are also a scientific contribution. I set out to distinguish soil groups, but actually ended up linking them and defining pedogenic trends: a better end result in my opinion!

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Editor's Note

The Midlands Consortium is a group of eight Universities in the Midlands of England who pool resources to provide a series of 10 techniques-focused half-day training sessions for first year Ph.D. students of geomorphology and related disciplines.

Recent publications by ESSC members

Included are the citation details of papers and books produced by ESSC members. These provide a growing resource for exchange of valuable information to both research and teaching. The cumulative citation list is being added to and updated on the ESSC web site. Students of ESSC members (both undergraduate and postgraduate) are increasingly accessing this facility in their literature searches. Currently, the number of quoted publications cited on the web page is 572. Please e-mail the citation details of papers in international refereed journals since and including the year 2000 to any member of the Editorial team.

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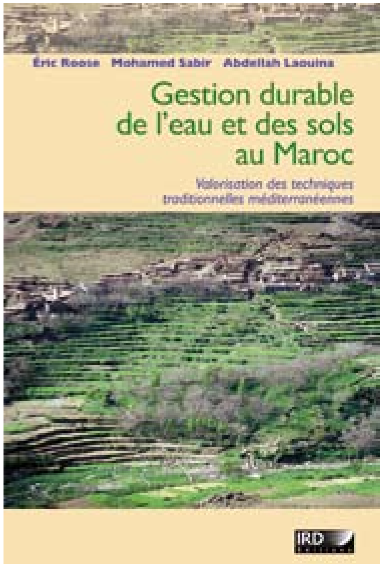

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Gestion durable de l'eau et des sols au Maroc: Valorisation des techniques traditionnelles méditerranéennes

Depuis plusieurs décennies, sous l'effet du défrichement, du surpâturage et de la pression démographique, les milieux naturels et les aires cultivées des régions semi-arides sont soumises à d'importantes dégradations. Malgré la mise en œuvre des grands projets de lutte antiérosive depuis les années 50, les espaces ruraux nord-africains ont notamment connu d'importantes baisses de productivité accompagnées d'une augmentation du risque de ruissellement et d'érosion des versants. Devant ce constat et face à la nécessité d'optimiser concrètement la gestion de l'eau et de restaurer la fertilité des terres, l'amélioration des techniques traditionnelles est la voie recommandée dans cet ouvrage pour mettre en œuvre des projets intégrés de développement en milieu rural.

Soutenue par le réseau érosion de l'AUF, l'équipe franco-marocaine de géographes, d'agronomes et de forestiers réunie dans cet ouvrage a analysé une trentaine de techniques traditionnelles de gestion de l'eau et des sols au Maroc. Testées dans différentes zones agro-écologiques et en tenant compte des facteurs économiques et humains, les techniques paysannes de lutte antiérosive sont présentées et commentées à la lumière des derniers acquis scientifiques.

A partir de ces expériences, l'ouvrage propose des combinaisons de techniques traditionnelles de gestion des sols, optimisées et adaptées aux conditions locales. Il s'adresse aux enseignants, aux étudiants et aux chercheurs, mais également aux ONG et aux décideurs en charge des programmes de développement rural au Maghreb et dans les régions semi-arides.

Sustainable Management of Water and Soils of Morocco: Validation of Traditional Mediterranean Soil and Water Conservation Techniques

For many years, Mediterranean semi-arid landscapes have been degraded by deforestation, overgrazing and extension of cropped areas under demographic pressure. Although large projects of SWC lasted 50 years, soil productivity was decreasing and runoff and erosion became more aggressive. In order to optimize the efficiency of water and fertilizer management, 30 traditional techniques were described in their ecological context. Then these were analysed in case studies on catenas or watersheds in the Moroccan mountains (Rif, Atlas, and Anti-Atlas). Finally, proposals to improve economic impacts were made, taking into account recent data of experimental studies at the runoff plots or small catchment scale under natural or simulated rains. An abundant bibliography of French-speaking researchers is presented.

This book is a synthesis of a 10 year research programme by teams of geographers, soil scientists, agronomists and foresters. It will be of interest to researchers, professors, students, NGOs and developers of the semi-arid areas of the world.

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The Celebration of 'World Soil Day 2010' in Italy: 'The Perception of Soil'

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Soil performs unique roles for the needs and well-being of society. Considering the increasing human pressure on soil, frequently without regard to its conservation, is the importance of soil properly recognized? The Celebration of 'World Soil Day 2010' in Italy was an important occasion to discuss this question. To honour this annual event, the Italian Society of Pedology (SIPe), the Italian Society of Soil Science (SISS) and the Chair of Pedology of the University of Palermo (Carmelo Dazzi) jointly organized a two-day meeting (2–3 December 2010) entitled **'The Perception of Soil'.** The mmeting was held under the patronage of the International Union of Soil Sciences (IUSS), European Confederation of Soil Science Societies (ECSSS), European Society for Soil Conservation (ESSC) and the International

Plate 1. Introduction to 'The Perception of Soil' of 'World Soil Day 2010' by Professor Carmelo Dazzi on 2 December 2010 in Palermo.

Humic Substances Society (IHSS). The main aim of the convention was to investigate how soil is perceived in different constituents of society. To achieve this objective, the meeting was organized into 14 keynote lectures, in which speakers discussed the perception of soil in their own specific area of expertise. These included soil regulations, disaster management, urban and landscape planning, finance and valuation, crop production, pedology, medical geology and journalism. There was also a Poster Session. The Conference was open to researchers, teachers, students, managers, and delegates of regional and national institutions.

In the Opening Ceremony, delegates of national and regional institutions and of scientific societies supporting the event, welcomed the Conference and Carmelo Dazzi (Co-ordinator of the Organizing Committee) inaugurated 'the Celebration of World Soil Day 2010' (Plate 1). The Convenors, Nicola Senesi (President of SISS) and Fabio Terribile (President of SIPe), introduced the invited speakers.

At the end of the talks, a Service Awards Ceremony was dedicated to retired professors who had contributed to the development of soil awareness in Italy. These included Angelo Aru, Paolo Baldaccini, Corrado Buondonno, Giovanni Fierotti, Fiorenzo Mancini and Fiorenzo Ugolini. The first meeting day ended convivially with the social dinner. The second day was dedicated partly to further talks, and to the Poster Session, in which Ph.D. students and researchers exhibited their scientific activities in Soil Science.

The choice of the specific theme **'The Perception of Soil'** allowed us to discover many different perceptions of soil. However, soil is rarely recognized as a complex and living system. The concluding remarks of the 'Celebration of World Soil Day 2010' concerned the inadequate perception of soil in society and of its vitality, functions and complexity. For this reason, the final official motion of the meeting unanimously requested a more active role for local and national institutions to legislate, according to the European Strategy, to conserve the soil resource. These institutions should endeavour to create, on regional and local scales, strong co-operative networks to support environmental policies. These should include recognizing soil health and quality as important factors in planning investments and productive activities; to support the initiative to spread 'soil culture' through mass media, and to sensitize society to the human impact on soils and its consequences.

E-mail: camilli@unipa.it

Europe Launches the UN Decade for Deserts and the Fight against Desertification (London, UK, 16 December 2010)

This Report was prepared by Maria Hannah Bass (UNEP-WCMC) and Wagaki Mwangi (UNCCD) and presented by J.L. Rubio (ESSC).

London played host to the European launch of the 'United Nations Decade for Deserts and the Fight against Desertification' (UNDDD), which will run from 2010–2020 with a view to securing drylands for future generations. At the event, which took place on 16 December 2010, geographers, scientists, development experts and policy-makers gathered to discuss the challenges and opportunities facing drylands under threat from climate change and land degradation (Plate 1). The event comprised of a seminar followed by a press conference, and signature of the Record of the regional launch.

In his opening remarks, the moderator, Dr Matt Walpole (United Nations Environment Programme World Conservation and Monitoring Centre, UNEP-WCMC) noted the importance of the Decade and how it intersected with the 'UN Decade for Biodiversity,' as well as other relevant UN years, such as the '2010 International Year of Forests.' He said these streams should come together and the UN system should work hard to raise awareness on these important topics, emphasising the synergistic opportunities for each. Dr Walpole said by speaking about the issues from their own perspectives, the panellists would offer challenging viewpoints for consideration.

Mr. Luc Gnacadja (Executive Secretary of the UN Convention to Combat Desertification, UNCCD) said *"drylands are the new frontier of investment"* as possibilities open up in sectors as diverse as carbon markets, tourism and high-value dryland products, such as cashmere and vicuna. However, change can only happen at grass-roots level and policy must seek to empower local communities working with an intimate and specialized knowledge of their environment. Launching the Decade, Mr. Gnacadja explained why we need to take action. *"First, because it is about our own food security. Second, drylands are homeland to one-third of the world's population, half of whom are the poorest. Third, water stress will increase. Fourth, eight of the 25 biodiversity 'hotspots' in the world are in drylands. And fifth, drylands play a vital role in global and local climatic regulation"*. Ranging from Mediterranean olive plantations to the freezing plains of the Tibetan Plateau, drylands represent incredible biodiversity. Yet, they are under increasing threat from land degradation that turns fertile soils into dust. The UN Decade aims to place initiatives to combat desertification at the centre of the global environment and development policies that address current major global challenges. Policy-makers will be encouraged to recognize the urgency of the interlinked threats. Thus, speakers at the launch stressed the key message that drylands must not be viewed merely as wastelands. Rather, they are places of opportunity.

Dr Alison Rosser (UNEP-WCMC) spoke about drylands from a climate change perspective, with a focus on what is special about drylands, the threats they face, the tools available to decision-makers and what policy-makers in Europe, in particular, can do about it. Using maps, Dr Rosser showed the potential impacts of global warming, within the context of the global economic crisis, projected population growth and a high level of global food insecurity, among other aspects. Dr Rosser asserted that global warming is expected to result in water shortages, a shift in the agricultural areas in the drylands, the range of species, an extension of the drylands areas in Eurasia, Africa and Australia and increasingly uncertain conditions for the dryland populations.

Dr Johannes Kamp (Senior Research Assistant, Royal Society for the Protection of Birds, RSPB) spoke about the impact of change in livestock grazing on biodiversity in the Eurasian Steppes. He reported that some species have benefited from overgrazing, but overall, huge populations of species are declining all over Europe due to agricultural intensification. More specifically, he reported loss of floristic diversity, strong decreases in bird diversity and abundance, the disappearance of 'typical' steppe birds and mammals and shifts in ecological zones.

Dr José Luís Rubio (President of the European Society for Soil Conservation, ESSC) provided the perspective from Southern Europe. He presented the worst and best case scenarios. He described soil as the skin of the Earth that stands between life and lifeless. Unlike the atmosphere which is 400 km deep or the 6300 km rock mass beneath it, soil is only a few centimetres deep. He said the world's soil only weighs 0.000000000000014 % (1.4×10^{-15} %) of the Earth, but contributes 90 % of our food. Dr Rubio explained the causes of land degradation in Southern Europe, and its outcomes, which include the loss of subsistence, forced migration and conflict.

Desertification is both a cause and a consequence of the extreme poverty suffered by many drylands inhabitants, 'the forgotten billion' driven to overgrazing without access to good water supply. Climate change exacerbates desertification and, since drylands contain a quarter of the world's carbon stocks, their protection is crucial in the struggle to reduce greenhouse gas emissions.

"Local people are the principal actors" and *"they are not victims of something beyond their control"* said Dr Camilla Toulmin (Director of the International Institute for Environment and Development, IIED). She pointed to the success of Mali villagers, with whom she has worked closely for 30 years, who are now enjoying high prices for their sesame as international demand for the crop soars. She added *"maintaining a thriving agricultural system requires the ability to continue with good production and taking local people as the principal actors".* Dr Toulmin called for action directed towards improving soil and water conditions and new varieties of seed, and recognizing the rights of people to control land, territory and vital resources. She concluded *"it is only through taking the long term view that you can separate the trends from the noise and spot the patterns of positive change".*

Dr Michael Mortimore (Drylands Research) provided the investment perspective. He said drylands are non-equilibrium environments. Their extreme and uncertain conditions interact with human activities to create an environment without equilibrium. Even so, he outlined 14 areas with great potential for investment in drylands, and analysed their investment chains. An emerging paradox of this environment, Dr Mortimore said is that *"more people means less erosion"* and evidence which suggests that intensive systems, such as those practised by small-holders in drylands, are more sustainable than the extensive agricultural systems widely practised in developed countries.

The participants viewed the UNDDD both as a period for urgent action and an opportunity to see real improvements. The event was jointly organized by the UNCCD, UNEP-WCMC and IIED. The UN tasked the leadership of the Decade's events to the UNCCD, UNEP, United Nations Development Programme (UNDP), the UN Department of Public Information (DPI) and the International Fund for Agricultural Development (IFAD).

Plate 1. Panel discussion at the launch of the 'UN Decade for Deserts and the Fight against Desertification' in London (UK) on 16 December 2010.

For information on the Decade launch, contact:

E-mail: wmwangi@unccd.int or
Jessica.smith@unep-wcmc.org

For more information on the UNDDD, contact the Task Force at:
E-mail: arce@unccd.int
Tel. 00 49 228 815 2820

Web site: http://www.unddd.unccd.int

The Summer Soil Institute

Addressing Environmental Challenges with Current and Emerging Techniques

What: A summer course for graduate students, professionals, faculty, and K12 teachers
When: 12–25 June 2011
Where: Colorado State University, Fort Collins, Colorado, USA

The Summer Soil Institute provides a unique opportunity to gain a fundamental and applied understanding of soil biology, chemistry and physics with world-renowned faculty. Students will gain hands-on experience with laboratory and field techniques and will gain an enhanced appreciation of the importance of sustainably managing our soil resources. The course will be limited to a maximum of 25 students. Applications will be reviewed starting 12 March 2011.

A limited number of scholarships will be available to meritorious applicants, based on financial need.

Location:

The course will be based on the campus of Colorado State University (CSU), which is nestled against the foothills of the Rocky Mountains on the western edge of the Great Plains of the USA. We will take advantage of the high diversity of soils within a short drive with field trips to the Fraser Experimental Forest and the Shortgrass Steppe Long-Term Ecological Research Site. The Institute will culminate with student presentations and a banquet at Pingree Park, where students will be able to enjoy the mountain landscape just north of the Rocky Mountain National Park.

Accommodation:

On-campus housing and meals will be available at the state-of-the-art Academic Village at Colorado State University. The green Academic Village opened in 2008 and was built to high standards of sustainability.

Instructors:

Thomas Borch: Environmental Soil Chemistry.
M. Francesca Cotrufo: Soil Organic Matter and Stable Isotope Applications.
Eugene Kelly: Pedology and Geochemistry.
John Moore: Soil Ecology, Food Web Modelling.
Mary Stromberger: Soil Microbiology.
Joe Von Fischer: Trace Gas Biogeochemistry.
Diana Wall: Soil Sustainability, Soil Fauna.
Matthew Wallenstein: Soil Microbial Ecology and Molecular Techniques.
Funding for the Institute is provided by the USDA AFRI Program.

For more information and to apply, please visit our website:
http://soilinstitute.nrel.colostate.edu/
E-mail: soil@nrel.colostate.edu

Dr Ranjan Bhattacharyya wins the 'Golden Jubilee Young Scientist Award (2010)' from the Indian Society of Soil Science

Ranjan Bhattacharyya has won the prestigious 'Golden Jubilee Young Scientist Award (2010)' from the Indian Society of Soil Science. The award (in the form of a gold medal and a certificate) was presented to Ranjan during the 75th Annual Convention of the Society, held in Bhopal (India) during 14-17 November 2010.

Ranjan was unanimously selected as the recipient of the reward for his outstanding contribution to soil science in the Indian Himalayas for a decade. Ranjan and his colleagues are evaluating the impacts of conservation tillage, diversified cropping systems, organic farming and integrated nutrient management practises on carbon sequestration and soil quality parameters in arable soils in the region. In 2009, Ranjan was also selected as winner of the 'Asian Scientist of the Year' by the World Association for Soil and Water Conservation' (WASWAC).

Ranjan said "I am extremely delighted to be named as one of the best young soil scientists of my country. I am thankful to the Indian Society of Soil Science for choosing me and to everyone who supported me for the realization of the research work in the remote hilly terrain of the Indian Himalayas."

At the University of Wolverhampton (UK), Ranjan worked as a member of the team in the EU-funded BORASSUS Project and significantly contributed to advancing our knowledge on using biogeotextiles for soil and water conservation. Ranjan was awarded his Ph.D. in 2009. The Ph.D. thesis 'Utilization of palm-mat geotextiles for soil conservation on arable loamy sands in the United Kingdom' (The University of Wolverhampton, 326 pp.) was reported in ESSC Newsletter 2010/1. The full pdf of the thesis is available from the University of Wolverhampton e-Library 'WIRE' at:

http://wlv.openrepository.com/wlv/

Web sites:

Indian Society for Soil Science:
http://www.isss-india.org

BORASUSS Project:
http://www.borassus-project.net

The address of Ranjan is:
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India

E-mail: Ranjan_vpkas@yahoo.com

The 'Regional Engineering, Architecture and Agronomy Council of Rio de Janeiro (Brazil) Environmental Award (2010) in Geography' is awarded to Professor Antonio José Teixeira Guerra (Federal University of Rio de Janeiro, Brazil)

The 'Regional Engineering, Architecture and Agronomy Council' of Rio de Janeiro (Brazil) ('Conselho Regional de Engenharia, Arquitetura e Agronomia;' CREA) Environmental Award is granted every year. The aim of the Award is to recognize individuals and institutions in the State of Rio de Janeiro who have made distinguished contributions to environmental protection and conservation. These awards are within the themes of Engineering, Architecture, Agronomy, Geology, Geography, and Meteorology. This initiative allows the identification of scientists who are contributing to improved quality of life and who serve as inspirational exemplars.

Plate 1. Professor Antonio José Teixeira Guerra with his 'Regional Engineering, Architecture and Agronomy Council of Rio de Janeiro (Brazil) Environmental Award (2010) in Geography.'

The Geography Winner of the Environmental Award (2010) is Professor Antonio José Teixeira Guerra (Plate 1). Antonio (Tony) graduated in 1974 and received his Masters degree in 1983, both in Geography at the Federal University of Rio de Janeiro (UFRJ). He received his doctorate in 1991 for a thesis on soil erosion from the University of London (UK). In 1997 Tony completed a Post Doctoral Fellowship at the University of Oxford (UK). Currently, he is Professor of Physical Geography at the Federal University of Rio de Janeiro and Head of the 'Laboratory of Environmental Geomorphology and Soil Degradation' (LAGESOLOS). Tony is working on several research themes. These include geomorphology, soil erosion, mass movements, land rehabilitation and environmental management. Tony has actively contributed to environmental improvement and has participated in several projects concerned with environmental conservation and rehabilitation. He also worked at the 'Brazilian Institute of Geography and Statistics' (IBGE) and several Brazilian Universities. He has already won three national awards (from the Federal University of Rio de Janeiro, Rio de Janeiro City Council and the Geographers Union of Ceara State). Tony has written and edited 17 books on geomorphology and environmental issues, written 95 articles in Brazilian national and international journals and completed 28 monographs. He has supervised numerous theses (25 M.Sc. theses and 20 Ph.D. theses). The Award was presented at a Special Ceremony at CREA-RJ in Rio de Janeiro on 6 December 2010.

The Award was presented by Dr Agostinho Guerreiro (President of CREA-RJ), who commented that Tony deserved the Award for all the work he has been doing for many years to improve the environment in Brazil.

On behalf of the Brazilian research community, I congratulate Professor Guerra for this well deserved Award!

Fernando Bezerra
Federal University of Rio de Janeiro, Brazil
E-mail: fernangeo@yahoo.com.br

ESSC membership list and contact details

Web Based Bulletin Board

The ESSC wishes to rapidly disseminate information to its members. Please forward information to the ESSC web site to be placed on our ESSC Bulletin Board. These could include searches for potential collaborators for research proposals, calls for research proposals, job opportunities, research studentship opportunities, impending conferences and other items of important information for rapid dissemination. Of course, we will also continue the regular circulation of information via our Newsletter. The ESSC web site is:

http://www.essc.sk

ESSC membership list and contact details

The full ESSC membership list is held on the ESSC web site. Under 'members' you can obtain a full listing. Also under 'members' you can click on any member country and find a listing of members in the selected country.

We are trying to keep the membership list on the web site up-to-date. Please check your details and let us know if there are any necessary correction(s). If your details change, also please let us know. Some members have requested that we do not add their e-mail addresses to the web site, to avoid uninvited 'spam' e-mails. Of course, we respect this request. Therefore, while we retain a list of the e-mail addresses of ESSC members, this list will not be available on the web site.

Editorial matters in Bratislava are handled by Ida Kurincová Kriegerová. In terms of membership lists, contact details and the ESSC web site, please send updated information to Ida at:

E-mail: i.kriegerova@vupop.sk

Please also use and refer to the **'Directory of European Organizations and Persons Working on Soil Protection'** as a reference source for European colleagues, both members and non-members of the ESSC. This publication contains the e-mail addresses of most ESSC members and will be subject to periodic updates. The reference citation is:

Rubio, J.L., Imeson, A.C., Bielek, P., Fullen, M.A., Pascual, J.A., Andreu, V., Recatala, L. and Ano, C. (2006). **Directory of European Organizations and Persons Working on Soil Protection.** Soil Science and Conservation Research Institute, Bratislava, 190 pp. (plus CD-Rom).

FORTHCOMING DATES FOR YOUR DIARY

The Rainfall Simulator Workshop in Trier, Germany, from 30 June to 1 July 2011

Dear Colleagues

We are pleased to officially invite you to the **Rainfall Simulator Workshop in Trier, Germany from 30 June to 1 July 2011.**

We are looking forward to welcoming you in Trier. Please bring your small portable rainfall simulator for the experimental part of the workshop!

If you have any questions please do not hesitate to contact Thomas Iserloh (e-mail: iserloh@uni-trier.de).

Yours sincerely

Johannes B. Ries and Thomas Iserloh

E-mail: iserloh@uni-trier.de

International Symposium on Erosion and Landscape Evolution (ISELE)

Sponsored by the American Society of Agricultural and Biological Engineers will be held at the Hilton Anchorage Hotel, Anchorage, Alaska, USA from 18–21 September 2011

PURPOSE:

Soil erosion caused by water and/or wind is a continuing problem throughout the world that threatens the capacity of the Earth to produce food, fibre and renewable sources of energy for an ever-increasing population. Additionally, eroded sediment is a major air and water pollutant, causing many detrimental off-site impacts. Erosion by wind and/or water processes continually impacts the evolution of landscapes. With global climate change, erosion and landscape evolution may be accelerated, particularly in regions such as Alaska, where increases in air temperature of just a few degrees may shift large landscape areas from frozen to thawing and thus more erodible conditions. This Symposium provides a forum for participants to discuss the current status and the future of soil erosion research.

MEETING PROGRAMME:

The Symposium programme will include volunteered presentations, invited presentations and a technical tour. Volunteered presentations will be divided between oral and poster formats. All presenters are invited to provide a 1-page extended abstract for inclusion in a book of abstracts, as well as an 8-page single-spaced camera-ready paper for inclusion on a CD-ROM, both of which will be distributed at the meeting.

TOPIC AREAS:

- Erosion Processes (detachment, transport, deposition).
- Prevention and Control of Upland and In-Stream Erosion.
- Highly Disturbed Lands, Urban Areas, and Arid Lands.
- Erosion Processes in Wetlands, Coastal, and Glacial Areas.
- Aeolian Erosion and Fugitive Dust Emission.
- Impacts of Global Change on Erosion Processes and Landscape Evolution.

For Symposium information, please contact:

Dr Debasmita (Debu) Misra
Symposium Co-Chair
Associate Professor
University of Alaska
Fairbanks
Alaska
USA

Tel.: 001 907 474-5339
Fax: 001 904 474-6635
E-mail: ffdm1@uaf.edu

ASABE Web site: http://www.asabe.org
ASABE Meetings Web site: http://www.asabe.org/meetings/erosion2011/index.htm
ASABE ISELE Abstract submission page:
http://www.asabe.org/meetings/cfp/call.cfm?mtg_code=erosion2011

For other information please contact:

Sharon McKnight
ASABE Meetings and Conferences
2950 Niles Road
St. Joseph
Michigan MI 49085-9659
USA

Voice: 001 269-428-6333 (Eastern US Time Zone)
Fax: 001 269-429-3852
E-mail: mcknight@asabe.org

The Symposium will be held in conjunction with the Annual Meeting of the **Association of Environmental and Engineering Geologists,** which is being held 19–24 September 2011, also at the Anchorage Hilton.

1st International Conference on
SUSTAINABLE WATERSHED MANAGEMENT

First Announcement and Call for Papers

FIRST INTERNATIONAL CONFERENCE ON
SUSTAINABLE WATERSHED MANAGEMENT
ISTANBUL, 19–23 SEPTEMBER 2011

OBJECTIVE and SCOPE of the CONFERENCE SERIES

The overall objective of this Conference Series is to enhance and evaluate, at the global level, decision support tools and models for the sustainable use and development of watersheds. This objective will be accomplished by:

- Integration of existing expertise and advancing knowledge.
- Strengthening scientific and technological excellence.
- Increasing scientific acceptability through publications.
- Organizing training programmes.
- Establishing web-based platforms.

The series of Conferences will be structured to address these issues. Pre-conference courses will be offered to provide technical training for conference participants who are unfamiliar with tools for integrated watershed management.

The First Conference will provide participants with an opportunity to develop understanding and skills in advanced decision support tools and models for sustainable management of watersheds. Participants from all over the world will exchange knowledge on how to use advanced tools for assessment and decision-making that provide the ability to manage watersheds to balance economic and environmental considerations. Participants will benefit from applying the sustainable use and development models to minimize and mitigate anthropogenic effects on the natural capital of water resources, watersheds and socio-economic systems. This will lead to recommendations based on an 'ecosystem approach' for decision-making directed at protection of human security and peace. Furthermore, group sessions will result in the identification and harmonization of terms and principles of integrated watershed management as well as recommendations for application and implementation of sustainable use and development practises in developing countries.

The outcome will be sharing of knowledge, ensuring lasting integration of information and data, networking of experts and stakeholders across and throughout the participating countries, expanding use of scientific tools to promote sustainability on a watershed basis, and to spread sound watershed management practises worldwide.

Conference Themes

- **Good watershed management practises:** examples from various countries including climate change challenges and trans-boundary problems to be presented by invited key speakers.
- **Decision support tools:** monitoring, GIS, data/information management, indicators, ecological economics, cost/benefit analysis, decision making models, legislation and policies, participatory methods/water user partnerships.
- **Models:** integrated watershed model applications for watershed management.

PRELIMINARY PROGRAMME

Pre-Conference Activities (12–17 September 2011)

Course: Modelling with SWAT (R. Srinivasan and K. Abbaspour).
Course: Modelling with MOHID LAND (R. Neves and F. Braunschweig).
Course: Modelling with MOHID WATER (R. Neves and L. Fernandes).
Course: Modelling with WASP (R. Ambrose and A. Ekdal).
Course: Theory and Practise of Hierarchical Decision Making (B. Srdjevic).
Course: MODELKEY DSS: a decision support tool for river basin Assessment and Management (E. Semenzin and S. Gottardo).
Course: GIS for Environmental Projects (D.Z. Şeker).
Course: HEC-RAS (R. Walton).
(The daily programme will be presented in the Second Announcement).

Tentative Conference Programme (19–23 September 2011)

19 September: Integrated Watershed Management Practise (invited key-speakers).
20 September: Concurrent Sessions: one each on the basic conference themes (Decision Support: Tools and Models).
21 September: Concurrent Sessions: one each on the basic conference themes: Decision Support: Tools and Models).
22 September: Istanbul tour and Conference dinner.
23 September: Panel meetings (concurrent meetings).
Conference General Assembly meeting: conclusions and results.

Post-conference Activities (24–30 September 2011)

Optional 3–5 days excursion to Ephesus, Troy or Cappadocia or Pamukkale (details will be provided in the Second Announcement).

SUBMISSION OF ABSTRACTS AND PAPERS

All interested contributors are invited to submit abstracts of oral or poster presentations. Abstract submissions must be sent to the Conference Secretariat by e-mail <suwama2011.conference@igemportal.org> before 17 January 2011. Authors should identify their intent of submitting an oral or poster presentation while registering online.

Abstracts of scientific or practical approaches will be reviewed by the Conference Scientific Committee. After the approval of abstracts, authors will have the opportunity to submit a full paper for publishing in a scientific journal (see instructions below). All oral and poster presentations must submit an abstract of 500-1000 words. Abstracts must be written in English with Times New Roman 11 character format. Abstracts will be published in the short Proceedings to be handed out at the Conference.

Full paper submission for publication. Papers must be original and previously unpublished scientific research (maximum 6000 word manuscript). Papers will be submitted for publication in the relevant scientific journal. Papers must be written in English according to the guidelines from the publisher, which will be distributed with the Second Conference Announcement. Please note that all papers are subject to the peer review process.

If you plan to submit an abstract and a full-paper, please note the following schedule:

Abstract submission deadline	17 January 2011
Acceptance of submissions	15 March 2011
Draft programme with the second Announcement	4 April 2011
Full paper submission deadline	24 June 2011
Final programme	25 July 2011

REGISTRATION

All participants should register between 8 November 2010 and 1 September 2011, following instructions given on the Conference website. Please note that number of participants will not exceed 300 and may be restricted by the Organizing Committee.

LANGUAGE

The language of the Conference is English.

CONFERENCE VENUE

The Conference will be held in Hotel Artemis Marin Princess, Kumburgaz, Istanbul.

REGISTRATION FEES AND ACCOMMODATION (€)

Registration fee of the Conference: 400
Early registration fee (by 15 March 2011) 300
Reduced fees for young scientists (less than 30 years old)
from developing countries 200
Reduced fees for students 200
Registration fee for each course for
Conference registered participants 150
Registration fees only for course participants 300

Conference registration fee includes proceeding of abstracts, welcome cocktail reception, Istanbul tour (except entrance to museums) and Conference dinner, coffee breaks and VAT (Value Added Tax). The course fee only includes the participation in all lessons, the course material (which will be distributed during the course), VAT and coffee breaks. After registering on-line, please transfer Conference and course fees to:

YAPI ve KREDİ BANKASI, Çatalçeşme İstanbul Branch TURKEY
IGEM Account No. 0329 66893324 (EURO Account)
Swift: YAPITRISFEX IBAN: TR060006701000000066893324

Please include your full contact details on the bank debit slip and E-mail or fax this slip back to: suwama2011.conference@igemportal.org or 00 90 216 361 22 35.

Details about accommodation and optional excursion will be presented in the Second Announcement. Cost of accommodation will be ***circa*** €75 per day for single room including three meals (breakfast, lunch and dinner).

SECOND ANNOUNCEMENT

The second Announcement will appear at the Conference webpage on 4 April 2011: http://www.igemportal.org/?Dil=1&SID=689

Contact Details:

Conference Organization Secretariat: http://www.igemportal.org/?Dil=1&SID=689
E-mail: suwama2011.conference@igemportal.org
skype: suwama.igem
Fax: 00 90 216 3612235
GSM: 00 90 530 4694432.

BARI: THE CITY HOSTING THE CONGRESS

The City of Bari has approximately 400,000 inhabitants, and is located in South-East Italy, on the Adriatic coast. Due to its location, Bari holds traditional strong relationships with several European countries, especially the Balkan countries and with countries on the eastern and southern Mediterranean coast. Bari hosts several institutions that hold co-operative and promotional activities, educational programmes, professional training and follow-up courses, together with Universities and other organizations of the Mediterranean, European and extra-European countries. Their involvement in the Congress programmes and objectives will surely contribute to the enrichment, enlargement and diversity of the active participation and to the potential transferability of the scientific achievements of the initiative.

CONGRESS PRESIDENT

Professor Nicola Senesi
University of Bari 'Aldo Moro'
Dipartimento di Biologia e Chimica
Agro-Forestale ed Ambientale
Via Amendola, 165/A–70126
Bari
Italy

E-mail: senesi@agr.uniba.it

ORGANIZING SECRETARIAT

Selecto Srl
Society of Quality Management Systems
Via Roberto da Bari
108-70122 Bari
Italy


ECSSS
EUROPEAN CONFEDERATION
OF SOIL SCIENCE SOCIETIES (ECSSS)
4° International Congress
EUROSOIL 2012
Soil Science for the Benefit
of Mankind and Environment
Fiera del Levante, Bari - Italy
2-6 July 2012
FIRST ANNOUNCEMENT
AND CALL FOR PROPOSALS

Piazza Campitelli
1-00186 Roma (Rome)
Italy

Tel. 00 39 080 5218556
Fax 00 39 080 5245166
E-mail: info@eurosoil2012.eu

Web site:
http://www.selectocongressi.com

Reminder for the next issue:

Articles, reports, letters, views or comments on any aspect of soil erosion and conservation in Europe are always welcome.

We invite proposals for special thematic issues of the Newsletter. We also welcome any comments on the ESSC Newsletter and suggestions on how it can be improved and developed.

Do not forget to send in your details of the following information:

(i) Reviews of recent conferences.
(ii) Recent grant awards.
(iii) The citation details and abstracts of completed Ph.D. and M.Sc. theses.
(iv) Newly enrolled Ph.D. research students, title of their research topic and names of research supervisors.
(v) Recent staff institutional movements/promotions.
(iv) A reference list of your 'new' international refereed scientific journal papers, which have been published recently (since and including the year 2000).
(v) At the ESSC Council at Průhonice (Czech Republic) in June 2009, it was agreed that the Newsletter will present a series of national reports on soil erosion and soil conservation activities in individual European countries. If you would like to volunteer a contribution, please contact any member of the Editorial team.

Send these details to either:
Professor Mike Fullen: m.fullen@wlv.ac.uk
or
Dr Colin Booth: c.booth@wlv.ac.uk
and they will include this information in the next issue.

PLEASE NOTE:
We publish four Newsletter issues per year. The deadlines are:
10 January; 1 April, 1 July and 1 October.

Some Closing Thoughts:

"The flower needs the mud out of which it grows". *(Eckhart Tolle, 2006)*

"Thus, to know humanity;
Understand earth.
To know earth,
Understand heaven.
To know heaven,
Understand the Way.
To know the Way,
Understand the great within yourself".

(Lao Zhi, The Dao De Jing, from Verse 25)

"Just for today, till your mental soil with determination. Fertilize your emotional soil with positive words. Plant the seed of your heart's desire with your disciplined efforts".

(Iyanla Vanzant, 2000)

"The sleep of reason breeds monsters". *(Francisco de Goya, 1746-1828)*

Dreamers

"They are the architects of greatness, their vision lies in their souls, they peer beyond the veils and mists of doubt and pierce the walls of unborn Time.

The belted wheel, the trail of steel, the churning screw are shuttles in the loom on which they weave their magic tapestries. Makers of Empire, they have fought for bigger things than crowns and higher seats than thrones. Your homes are set upon the land a dreamer found.

The pictures on its walls are visions from a dreamer's soul. They are the chosen few-the blazers of the way. Walls crumble and Empires fall, the tidal wave sweeps from the sea and tears a fortress from its rocks. The rotting nations drop from Time's bough, and only things the dreamers make live on".

(Herbert Kaufman, 1878-1947)

"The gloomy soul aggravates misfortune, while a cheerful smile often dispels those mists that portend a storm".

(Lydia Sigourney)

"You are the Michelangelo of your own life. The David you are sculpting is you".

(Joe Vitale, 2006)

AIMS OF THE SOCIETY

The ESSC is an interdisciplinary, non-political association, which is dedicated to investigating and realizing 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,

Informing the public about major questions of soil conservation in Europe,

Collaborating with institutions and persons involved in practical conservation work in Europe.

The ESSC aims at co-ordinating 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 problemes 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-politica, 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 cientificos, 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.

Visit the ESSC Website: http://www.essc.sk

MEMBERSHIP FEES

I wish to (please mark appropriate box):

- Join the ESSC
- Renew my membership of the ESSC
- Know whether I have outstanding membership contributions to pay

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Please send this form to: ESSC Treasurer, Dr Wim Cornelis, Department of Soil Management and Soil Care, Coupure links 653, B-9000 Gent, BELGIUM.

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