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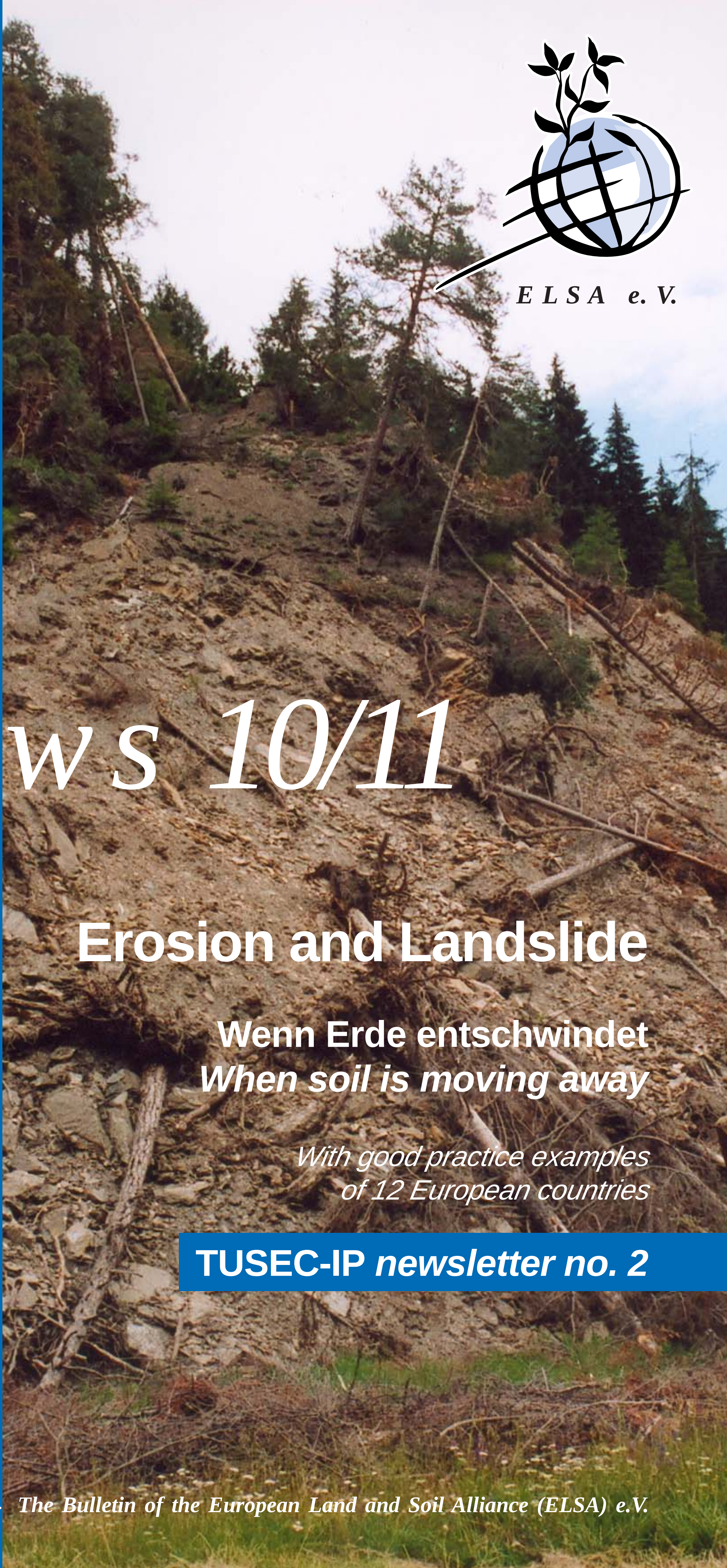

ELSA e. V.

Erosion and Landslide

Wenn Erde entschwindet
When soil is moving away

With good practice examples of 12 European countries

TUSEC-IP *newsletter no. 2*

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Cover Photo: Landslide in the Alpine Space. R.D. Jenny, Sent (CH)

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editorial

Erosion and Landslide – When soil is moving away

Dear Members and Friends of the European Land & Soil Alliance

*On 23/24 September 2004, the 3rd International Conference of the European Soil and Land Alliance on the topic "**Erosion and Soil Protection – a Challenge for Local Authorities**" will be held in Bolzano. With this special issue of the local land & soil news we would like to contribute to successfully enhancing erosion prevention in the framework of the European Soil Protection Strategy and as a common task of all regions and local authorites concerned. We would like to thank all authors for their competent contributions from many different countries and institutions in Europe. We would especially like to thank the Autonomous Province of South Tyrol for their full support of the Soil and Land Alliance, which enabled the publication of this issue and the execution of this year's International Conference.*

The erosion of soil material by wind and water is considered to be one of the greatest risks to soils worldwide. Countries and regions in Europe are more or less concerned by it and in different ways.
The erosion phenomenon has a diverse and very complex dimension with different positive and negative effects. Being a natural geological process, it means the decomposition of rocks through physical, chemical and biological processes. In the physical context, water seeps in small hollow spaces and crevices of rocks, it freezes and increases its volume so that, due to the change of frost and warming, rocks blast. The extension of the rocks caused by warming through irradiation and cooling in the night leads to crevices resulting in stone parts falling off. Chemical influences caused by the crystallisation of salts and minerals also have a blasting effect. Furthermore, stone material is decomposed by acids and oxidation. These processes are important to build up humus and deliver essential nutrients to microorganisms and plants for biological processes.
*To draw a conclusion: **Without erosion there will be no soil and no life!** We would like to show this important context by way of introduction as erosion is mostly only described as a destructive process. In this issue as well we mainly deal with soil erosion problems.*
Areas and many local authorities in the Alpine Space, on seashores, in arid regions but also along rivers and open arable land are particularly affected. The erosion of layers by wind and water may lead to great damages resulting in high costs which cannot be prevented without any provisions. The most important approach is the provision for risks and the interaction between human beings and nature. Best practice examples in different countries and areas provide an insight into methods and strategies on different issues. This issue also offers practical solution approaches in the fields of forestry, agriculture, coastal protection, spatial and landscape planning, which might be useful for local soil protection and risk prevention. The integration of the erosion topic into the European Soil Thematic Strategy is necessary for the European community and individual states involved with preventing natural hazards and promoting awareness of dealing with soils.

Editorial staff local land & soil news

Eine Landesprovinz setzt auf Vorsorge und Verantwortung bei der Naturgefahrenprävention

Bodenerosion ist eine Herausforderung für den kommunalen Bodenschutz. Auch diesem Thema widmet sich das Boden-Bündnis europäischer Städte und Gemeinden, ELSA e.V. Zu dieser internationalen Fachtagung habe ich die Schirmherrschaft übernommen, in der Überzeugung, dass wir alle eine große (Mit-)Verantwortung zu tragen haben zum Schutz unserer Böden als Lebensraum und Existenzgrundlage. Böden sind vielerorts einer rasanten Zersiedelung ausgesetzt oder werden durch Schadstoffe belastet. Dafür sind einzig wir Menschen verantwortlich. Böden, insbesondere im Alpenraum, aber auch an Küsten und in Trockengebieten, sind aber auch Naturgefahren ausgesetzt, die als Folge von Erosion abgetragen werden. Wo Naturgewalten im Spiel sind, müssen wir lernen, vermehrt mit der Natur zusammenzuarbeiten, um diese Naturgefahren zu mindern. Für mich als Landeshauptmann der Autonomen Provinz Bozen-Südtirol bildet die Vorsorge den wichtigsten Ansatz zur Bewältigung von Naturgefahren.

von Dr. Luis Durnwalder, Landeshauptmann der Autonomen Provinz Bozen-Südtirol, Bozen (I)
Schirmherr für die Internationale Jahrestagung des Europäischen Boden-Bündnisses (ELSA e.V.) 2004

Der Klimawandel zeigt starke Auswirkungen auf den gesamten Alpenraum. Schmelzen die Gletscher, taut der Permafrost auf, setzt Hangwasser ein. Kombiniert mit heftigen Niederschlägen, verwandeln sich Bergbäche in reissende Wildwasser und ziehen riesige Schuttmassen mit. Vernässte Böden setzen sich zunehmend in Bewegung und es kommt vermehrt zu Hangrutschungen und Murgängen. Zu Tal treten die Flüsse immer häufiger über die Ufer und überfluten weite Gebiete mit erheblichen Folgekosten. In den letzten Jahren häuften sich diese Schadenereignisse auch in Südtirol.

Ein anderer Faktor ist die Bodenerosion durch Abschwemmung auf offenen Ackerflächen, in Reblagen und Obstkulturen als Folge zunehmender Intensivierung in der Landwirtschaft. Im Südtirol setzte sich schon frühzeitig die Erkenntnis durch, wie wichtig die Dauerbedeckung der Kulturflächen ist, um den Abtrag der wertvollen Kulturerde aufzuhalten. Das landwirtschaftliche Bildungs- und Forschungszentrum Laimburg setzt sich seit vielen Jahren ein für eine bodenschonende und nachhaltige Agrarwirtschaft. Für Landwirte und Agrarfachleute führt sie verschiedene bodenkundliche Bildungsangebote und praktische Beratungen durch.

Den wirksamsten Schutz vor Naturgefahren und Erosion leistet der Schutzwald. Ungefähr ein Drittel des Südtiroler Waldes ist Schutzwald. Die Nachfrage nach der schützenden Wirkung des Bergwaldes wächst durch die zunehmende Siedlungs- und Wirtschaftstätigkeit innerhalb des begrenzten Siedlungsraumes. Um diese Waldflächen durch ausreichende Pflege in ihrem Bestand zu sichern, werden Schutzwaldverbesserungsmaßnahmen durch das Landesforstamt aktiv gefördert.

Die Landesabteilung Wasserschutzbauten hat sich in den vergangenen Jahren einen nachhaltigen und zeitgemäßen Hochwasserschutz zur Aufgabe gemacht. Naturnahe Flusslandschaften werden erhalten und hinsichtlich ihrer Schutzwirkung aufgewertet. Anhand eines Gewässerbetreuungskonzepts werden die zu treffenden Maßnahmen fortlaufend umgesetzt.

Gebiete mit potenziellen Naturgefahren sind in Gefahrenkarten festgehalten und werden von der Landesplanung laufend nachgeführt. In gefährdeten Einzugsgebieten werden spezifische Erosionsschutzmaßnahmen wie Hochlagenbegrünungen, Hochlagenaufforstungen, Hangsicherungsarbeiten an rutschgefährdeten Steilhängen getroffen. An Gewässern werden Uferbepflanzungen sowie Verbauungen nach ingenieurbaubiologischen Grundsätzen durchgeführt, um einen möglichst natürlichen Zustand und eine bessere Wechselbeziehung zwischen Wasser und Umwelt zu erreichen.

Im Bereich der Naturgefahrenprävention werden die Anstrengungen zum vorsorgenden Schutz von Mensch und Land, wie auch für aktive Katastropheneinsätze nicht nachlassen. Die notwendigen Schutzmaßnahmen werden durch den Zivilschutz und den geologischen Dienst fortgeführt, genauso wie die Programme für eine bessere Information der Bevölkerung. Sowohl bei der Vorsorge als auch im Einsatzfall ist ein optimales Zusammenwirken der zuständigen Stellen eine wichtige Voraussetzung. Durch die Ausweisung neuer Gefahrenschutzzonen und entsprechender Bauverbote können bestimmte Risiken für die Bevölkerung ausgeschlossen werden.

Der Landesentwicklungs- und Raumordnungsplan soll für eine maßvolle Entwicklung des Landes und zum Schutz der Berggebiete beitragen und durch eine noch bessere Koordinierung der Vorhaben den Schutz des Lebensraums verstärken. All die unverzichtbaren Schutzmaßnahmen dürfen selbstverständlich nicht zu einer Benachteiligung des ländlichen Raumes und der dort lebenden Menschen führen. Gezielte Struktur- und Entwicklungsprogramme werden uns weiterhin helfen, Defizite – soweit sie vorhanden sind – auszugleichen, bzw. eine maßvolle – oder wenn erforderlich – eine verstärkte Entwicklung dieser für unser Land wertvollen Gebiete zu erreichen. ■

Soil erosion as a main topic of the European Soil Strategy

Being the interface between the earth (geosphere), the air (atmosphere) and the water (hydrosphere), soils play a central role in our environment. Due to their environmental, economical, social and last but not least cultural functions, soils are essential for human life. Against this background, it is alarming that soils are under increasing pressure. The last three years were very important for soil protection when this issue came on the political agenda of the European community.

by Dr. Olaf Düwel, representing EuroGeoSurveys in the Technical Working Group on Erosion, Federal Institute for Geosciences and Natural Resources (BGR, Germany), & Dr. Liesbeth Vandekerckhove, Joint Chair of the Technical Working Group on Erosion, Flemish Ministry, Land Division, Brussels (Belgium)

The process started in 2001 when the European Commission adopted a proposal for a new environmental strategy *'Environment 2010: Our Future, Our Choice'* (CEC 2001). Amongst other areas, the proposal emphasised the importance of soils with regard to nature and biodiversity.

Following the strategic frame and having in mind the aspect that soil protection has to be based on sound information and assessment, the Commission in April 2002 published the Communication *"Towards a Thematic Strategy for Soil Protection"*, addressed to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions (CEC 2002). The Communication gives not only a definition of "soil" and its functions but also describes relevant soil threats. Soil erosion is identified as one of the most severe soil degradation processes in Europe. Saying this, soil experts in Europe are well aware that soil erosion is a natural process that is essential for soil formation. However, talking about erosion as a process of soil degradation means accelerated soil erosion, where the natural rate has been significantly increased by human activity.

Based on reports from Oldemann et al. (1991) and van Lynden (1995) the European Environment Agency assumes that the area affected is about 17 % of the total land area in Europe (EEA 2003). Water erosion causes thereby the main part with about 92 % of the affected area. Although the problem is most severe in the Mediterranean region, finally all parts of Europe are concerned to some extent. Losses of soil of 20 to 40 t/ha in individual storms, that may happen once every two or three years, are measured regularly in Europe (Morgan 1992). Losses of more than 100 t/ha do occur in extreme events.

Losses of soil material on the one hand and its deposits elsewhere have impacts on the soils themselves (on-site effects) as well as on other parts of the environment (off-site effects). On-site effects are losses of soil fertility and changes in soil functions. Off-site effects like sedimentation in neighbouring biotopes or other systems such as water reservoirs might lead to pollution and eutrophication. All these effects also produce economic impacts. Remarkably, the information on economic impacts is rather poor. The EU Communication "Towards a Thematic Strategy for Soil Protection" indicates that there are no comprehensive studies on the economic impact of soil erosion. However, available data suggests this is a major challenge (CEC 2002). The European Environment Agency for example estimates economic losses in agricultural areas in Europe at around EUR 53/ha per year, while the costs of off-site effects on the surrounding civil public infrastructure, such as destruction of roads and siltation of dams, reach about EUR 32/ha (EEA 2003). The CEC itself refers to a report provided by the Spanish Ministry of Agriculture, Fisheries and Food which

Although the Mediterranean region is affected by soil erosion in particular, soils in Central and Northern Europe are washed into the sea, too.

Severe Soil Erosion in Spain (Jijona Basin, province of Valencia). Photo: Olaf Düwel

Eroding field in Northern Germay. Photo: Friedrich Krone

indicates costs of about 280 million EUR per year in Spain including the loss of agricultural production, impairment of water reservoirs and damage due to flooding.
These are the reasons why the European Commission and the DG Environment in particular make many efforts to get this serious environmental and economic problem under control. Following the participatory approach, the Commission invited interested parties to a "Stakeholders Information and Consultation Meeting" that took place on February, 10th 2003 in Brussels. In order to develop an integrative soil protection strategy as a second step, an Advisory Forum and five Working Groups dealing with the main topics soil erosion, decline of soil organic matter, soil contamination, soil monitoring and research have been established. The aims of the working groups were to contribute to a proposal for a monitoring directive, to propose directions for future research and, as far as the specific working groups were concerned, to prepare a communication on actions in the priority areas *"soil erosion"*, *"soil contamination"* and *"decline of organic matter"*. Within this framework mandate the working groups met four times between June 2003 and April 2004 ending with comprehensive final reports.
These documents are all available at the public part of the CIRCA library, the communication platform of the EU DG Environment:
http://forum.europa.eu.int/Public/irc/env/soil/library ■

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The main objectives of the Technical Working Group on Erosion as one component of a European thematic strategy for soil protection

Since soil erosion was identified to be one of the most important soil threats in Europe, the Working Group on Erosion had to tackle this problem in particular. The overall objectives of the Working Group were already highlighted in the Communication ***"Towards a Thematic Strategy for Soil Protection"*** submitted by the European Commission in 2002:

- To protect soils against erosion, especially with regard to the viability of agricultural land and performance of soil functions.
- To harmonise information (data networks, soil surveys) in Europe.
- To develop an EU soil protection policy on erosion on the basis of prevention, precaution and sustainable approach.
- To pursue the integration of soil protection concerns related to erosion in major EU policies.
- To identify the local/regional elements to be integrated into soil protection policies as a consequence of the diversity of major soil types.

From these general questions 7 work packages were created with the following objectives:

1) Pressures and drivers causing soil erosion:
- Identify, describe and propose an analysis of relevant factors and human activities causing soil erosion in Europe.

2) Nature and extent of soil erosion in Europe:
- Appraisal of the current situation with respect to soil erosion using existing data, information systems and models. Establish harmonised criteria and guidelines for the development and use of indicators assessing the present soil erosion risk or state as well as trends in soil erosion over time.

3) Impacts of soil erosion:
- Assess the impact of soil erosion on sustainable use of soil and sustainable development and more specifically on economy, employment, social welfare and ecological health.

4) Measures and policy instruments to address soil erosion (prevention and remediation):
- Assess the most appropriate level of intervention for different measures or policy instruments (local, national, regional, EU) taking into account the wide variability of soils, climate and land use.
- Establish options and recommendations for measures or policy instruments, accompanied by a justification of choices, estimated impacts and costs and timelines.

5) Link with organic matter + contamination working group:
- Identify the relationship between soil erosion and declining soil organic matter (SOM).

6) Desertification:
- Identify, describe and analyse relevant factors and human activities causing desertification in Europe.

7) Monitoring Soil Erosion in Europe:
- Reflect and establish monitoring indicators and criteria related to actions and recommendations for erosion.

The final reports of all 7 work packages are available at the EU soil policy web page:
http://forum.europa.eu.int/Public/irc/env/soil/library

Gone with the wind, gone into water – soil erosion in Europe – pressures, state and impacts

Soil erosion has been identified as one of the three priorities to be tackled in the Soil Thematic Strategy (EC, 2002). Soil erosion, in fact, is one of the major and most widespread forms of soil degradation in Europe and, as such, poses severe limitations to the sustainable use of agricultural land (EEA, 2002). Soil erosion in Europe is mainly due to water and to a smaller extent to wind. The major causes are unsustainable agricultural practices, overgrazing and heavy rainfall. Soil erosion reduces the ecological functions of soil: the mainly biomass production, crop yields due to the removal of nutrients for plant growth, the soil filtering capacity due to the disturbance of the hydrological cycle (from precipitation to runoff).

by Anna Rita Gentile & Beate Werner; EEA – European Environment Agency, Copenhagen (DK)

The loss of plant nutrients and organic matter via eroded sediment reduces the fertility and productivity of the soil. This leads to a vicious cycle whereby farmers apply more fertilisers to compensate for the loss of fertility. Soil, once eroded, tends to be more susceptible to further erosion, and thus the cycle intensifies. The loss of applied nutrients in this way, represents a cost to the agricultural community, which is often underestimated (EEA, 1999).
The effects of soil erosion are expected to increase since climate change is expected to influence the characteristics of rainfall in the direction of a higher intensity of single precipitation events, which would be more erosive and lead to increased soil erosion, especially in Central Europe. Policies to combat soil erosion comprise a wide range of actions. This includes the adoption of sustainable farming practices and land planning to determine the most suitable crops for each area which should be implemented at the regional or local level with farm development schemes and farm advisory systems. Other important actions are the stopping of set asides of arable land; the reclamation of highly degraded lands or areas affected by desertification; the reforestation of watersheds and incentives to promote more sustainable activities. Within this context, the article provides a short summary of the status of soil erosion in Europe with particular reference to erosion in agricultural areas.

What are the causes of soil erosion?

Soil erosion is a natural phenomenon that can be exacerbated by human intervention. It is caused by a combination of factors. The predisposition of soils for erosion is given by physical factors such as climate (precipitation intensity), soil characteristics and slopes. The extent at which the erosion actually takes place mainly depends on the vegetation cover at the site and hence is driven by human activities. Agricultural management practices such as soil cultivation methods and tillage and soil conservation measures are the main factors determining the actual erosion rates.
Several economic sectors have an influence on the ways and the means by which human practices contribute to soil erosion. In addition to agriculture – the main driving forces in cultivated areas – tourism, land development and forestry may have an influence on soil erosion as they influence the uses of the land in non-agricultural areas. Examples could be given in intensively used mountainous or coastal areas where the vegetation cover is removed or disturbed due to infrastructure development and leisure activities. Floods and the climate change could also lead to major erosion events and the vegetation cover once disturbed might trigger natural events such as landslides (EEA, 2002, 2003a; EC, 2004a).

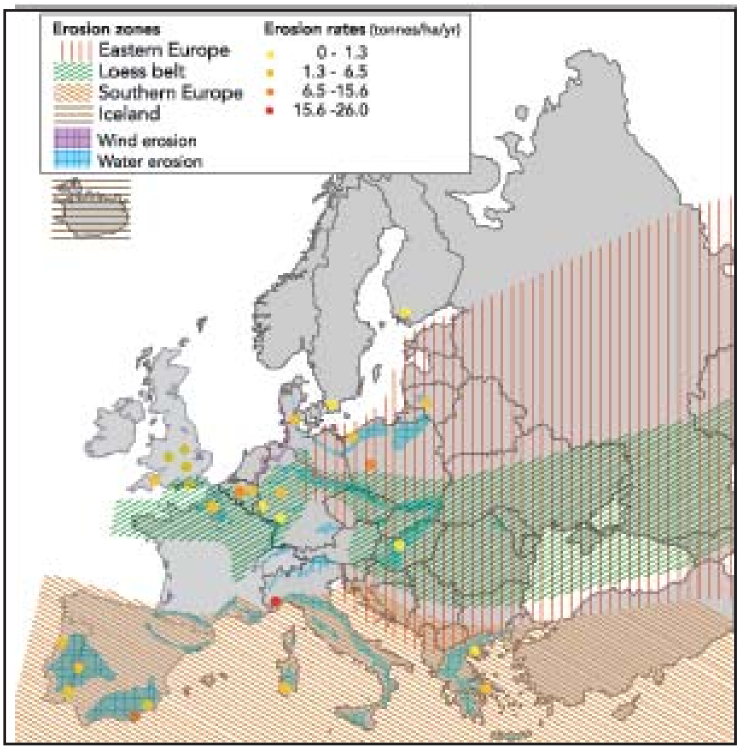
What is happening and where?

Soil erosion is taking place at different degrees in vast parts of Europe. The areas with the greatest severity of soil loss due to both wind and water erosion are the Mediterranean, the Balkan Peninsula and the countries surrounding the Black Sea (EEA, 2003). A quantification of the extent and the severity of soil erosion in Europe are given in Box 1.

BOX 1 The extent of soil erosion in Europe

There is very little quantitative information on actual rates and extent of soil erosion at the European scale. Pan-European information on risk of soil erosion by water has been recently made available through the Pan European Soil Erosion Risk Assessment (PESERA).
According to the GLASOD assessment[1], in Europe, excluding the Russian Federation, about 114 million ha or more than 17 % of the total land area are affected by soil erosion, of which more than 24 million ha or approximately 4 % show high or extreme degradation and nearly 70 million ha or 11 % are affected by moderate degradation. The major type of degradation is erosion by water (about 16 % of the total land area), while erosion by wind only affects 1.5 % of the territory.
The various regions of Europe show different patterns, for example in the former EU-15 and the EFTA countries the area subject to soil erosion is about 9 % of the total land area. It increases to 26 % in the new EU countries and candidate countries and to 32 % in the rest of Europe (excluding the Russian Federation)[2] (EEA, 2002). Data from national studies and singles case studies are also available.

[1]The GLASOD assessment, based on expert judgment, refers to actual erosion rates. For Central and Eastern European Countries (CEEC) a more recent assessment is available through the SOVEUR project.
[2]Source: EEA data elaboration from Glasod; data: UNEP and ISRIC through UNEP/GRID Geneva, 2001).



Map: Probable problem areas of soil erosion in Europe

The map shows regions where the nature of soil erosion (causes and impacts) is broadly similar, the location of "hot spots" within these regions and the associated measured rates of erosion from individual sites within the "hot spots" areas where data are available. It is important to note that the quality of the data used to make the assessment varies greatly.

Source: EEA elaboration form various sources (EEA-UNEP, 2000)

The map provides a broad overview of the location of soil erosion problems in Europe identified on the basis of published observations and field measurements. The map shows that there are three broad zones of erosion across Europe: a southern zone, a northern loess zone, and an eastern zone. Erosion is also an important problem in Iceland.

Southern Europe. Soil erosion greatly affects Mediterranean countries, where in the most extreme cases (arid and sub-humid climate) it leads to desertification. It is caused by a combination of harsh climate, steep slopes, thin vegetation cover and poor agricultural practices. In addition, frequent forest fires contribute to the desertification of marginal lands. Unsustainable irrigation systems contribute significantly to the salinisation and erosion of cultivated lands.

Central and Eastern Europe. Erosion is the most widespread form of soil degradation linked to agricultural mismanagement and deforestation. Past agricultural policies that focused on the increasing productivity have led to an inadequate use of mineral fertilisers, pesticides and heavy machinery. The situation is even worse in a vast area comprising Eastern Europe, Caucasus and neighbouring central Asian countries, where the most extreme forms of degradation have resulted in the desertification of large areas (EEA, 2003a).

Northern Europe. Erosion due to water is also becoming increasingly relevant in the northern loess belt, where moderate rates of soil loss can be observed. These mostly result from less intense rainfall falling on saturated, easily erodible soils. There is also a local wind erosion of light soils. Soil erosion is also a severe problem in Iceland (EEA-UNEP, 2000).

What are the impacts?

Soil erosion leads to both on-site and off-site impacts. *On-site impacts* are linked to changes of specific soil properties, such as its organic matter content, which influences the fertility and productivity of the soil, and its capacity to sequester atmospheric carbon. Organic matters and nutrients are transported away from the site together with the eroded soil.

In many areas of Europe, where soils have been cultivated for long periods and have been subjected to severe degradation processes, the content of organic matters is currently low or very low. In Southern Europe, in particular, it has been estimated that nearly 75% of the total land area analysed, corresponding to more than 100 million hectares, have a low to very low content of organic carbon in the topsoil (EEA-UNEP, 2000).

It has been calculated that in Austria, a potential loss of organic matters in agricultural soil due to erosion could be more than 150 000 tonnes per year, while a potential loss of nutrients, such as nitrogen and phosphorus, could be more than 15 000 and 8 000 tonnes per year respectively (Stalzer, 1995).

Other on-site impacts include the reduction of the rooting depth for crops, lower infiltration rates and the consequent limitation of the water holding capacity of the soil and small scale impacts on the plant growth for example due to the silting taking place in the down hill part of the cultivation area.

Off-site impacts are related to the sedimentation and deposition of eroded soil into adjacent areas. A major problem still is the phosphorus load that goes into water bodies with eroded soil particles through surface run-off. This contributes to the diffuse input of nutrients and to the eutrophication of rivers and lakes. As the phosphorus concentration in most European regions decreases due to the improved wastewater treatment, specific areas with a high phosphorus load from agricultural sources become more visible. For example, in two UK lakes (Loughs Neagh and Erne), concentrations of phosphorus have steadily increased in spite of reduced loads from point sources. These high concentrations were caused by a steady build-up of a surplus of phosphorus (arising from fertilisers) in the soils of the upstream catchments (EEA, 2003b). Other off-site impacts include contamination of soil in down hill sedimentation areas, increased sediment loads in down stream river sections and water reservoirs and the occurrence of landslides, which may damage the infrastructure (roads and railways).

The importance of on-site and off-site impacts in public awareness and policy development differs over Europe. In general, Northern European countries are more concerned with the off-site impacts of soil erosion, which may cause eutrophication in water courses, while Mediterranean countries are more concerned with the effects of desertification. Therefore, although the aim to reduce soil erosion is common, the answers lie in national solutions adapted to country needs (EC, 2004b).

More information on desertification is included in the next section, while the effects of climate change on soil erosion are discussed in Box 2.

BOX 2 The relationships between soil erosion and climate change (source EEA, 1999)

Climate change may affect erosion through the effects of drought and increased precipitation intensity. Droughts may increase the susceptibility of soil to wind erosion while heavy rainfalls may become more frequent under certain climate change scenarios (IPCC, 2001). On the other hand, areas with decreased content of soil organic matter, due for example to former erosion, may become important sinks for atmospheric carbon. In these areas conserving soil cultivation methods such as minimum tillage might contribute to both the recovery of soil fertility and carbon sequestration (EC, 2004b).

How may the climate change affect soil erosion in the future?

The extent and severity of soil erosion are expected to get worse since climate change is expected to influence the characteristics of rainfall in ways which might increase soil erosion, especially in Central Europe (Sauerborn et al., 1999 in EEA, 2003a). In particular, the modified patterns of precipitation, consequent to climate change, will probably induce greater risks of soil erosion depending on the intensity of rain episodes (IPCC, 1998). As a consequence, desertification is likely to become irreversible if the environment becomes drier and the soil becomes further degraded through erosion and compaction (IPCC, 1996).

Under the EC baseline scenario[1], the water erosion risk is expected to increase by the year 2050 in about 80% of EU agricultural areas, as an effect of the climate change. The increase will mainly take place in those areas where soil erosion is currently severe (Fig. 5; EEA, 1999; 2000).

[1]The baseline scenario is for the previous EU 15 and takes into account both policies in place and in the pipeline by August 1997. The assumptions are taken from the European Commission's pre-Kyoto business-as-usual scenario. For more details on the baseline scenario and the use of prospective analysis to support policy making refer to EEA, 1999 - chapter 1.1

Partial estimates of costs of the on-site and off-site impacts of erosion are provided in the contribution of Olaf Düwel & Liesbeth Vanderkerckhove (see page 4/5).

Desertification

Soil erosion may also contribute to desertification in some areas, although it is not the only driving force. Desertification is an extreme example of how ongoing soil degradation – due to the interaction of various factors such as climate and unsustainable use of water and land resources – may lead, under certain circumstances, to the gradual and progressive reduction in the capacity of the soil to support human and animal communities, vegetation and economic activities and how soil degradation may have social and political impacts. Therefore, a correct response to the problem would involve different levels of actions at the local, national and global levels, as well as actions to integrate environmental policies into sectoral policies. Desertification is not only a problem of regions of the world subject to an arid climate (drylands) but currently threatens parts of Southern and Central-Eastern Europe. Extensive areas in the Mediterranean region have become so severely degraded that they are no longer capable of supporting any profitable cultivation, resulting in land abandonment and depopulation (EEA, 1998). Moreover, very serious problems occur in neighbouring regions, especially in Northern Africa and Central Asia.

What can be done?

Policies to combat soil erosion comprise a wide range of actions. As agriculture is one of the main driving forces, the Common Agricultural Policy (CAP) represents one of the most important instruments. Especially the CAP reform provides new possibilities to influence land management practices. However, next to the CAP, other policies such as social policy, taxation and environmental regulations as well as open market forces are influencing the agricultural sector.

The development and implementation of cross compliance (Council Regulation 1782/2003) is a key instrument to reinforce the linkages between land management and soil protection positively. This requires that member states define farm management standards taking also into account environmental aspects of farm management and soil protection (Annex III and IV of Reg. 1782/2003).

This activity will be supported by the development of farm advisory systems. Education and training of land users, together with an increasing awareness of short-term and long-term environmental and economic benefits of soil erosion control, is a key element for influencing current agricultural practices (EC, 2004b).

Direct influence on farm management practices at the level of the single farm could only be provided by measures at the local scale, such as farm development schemes or in the framework of farm advisory systems. Explicit measures to combat erosion would concentrate on agricultural practices adapted to land capability and soil suitability. These should promote a protective vegetation cover and/or an organic debris (plant residues, litter) cover. Proper land use planning including crop selection and

diversification practices, which take into account the specific soil erosion risk, would be crucial, together with a proper planning of landscape elements (terraces hedges, proper size, shape and direction of agricultural fields and farm tracks). Soil management practices have to maintain suitable levels of organic soil matter; soil tillage should be adapted to the soil situation and the climate as regards intensity and timing and should be minimised where possible. Soil cultivation should follow contour lines and adequate machinery should be used to reduce soil compaction. In pasture areas, integrated land management systems could help to adapt the intensity of grazing to the capability of the soil (type of animal, season, stocking rates, etc.) (EC, 2004b).
Many European countries have voluntary codes of *Good Farming Practice (GFP)* which give advice on soil conservation measures. In general terms, good progress for soil conservation has been made in the agricultural sector through the agri-environment schemes and the introduction of the GFP (EC, 2004b).
In the enlarged EU, the implementation of agri-environment measures can have positive effects, but considerable effort is required to support the widespread adoption of these instruments in the new EU countries and in the candidate countries (EEA, 2004). Other prevention and mitigation measures have to concentrate on forestry and the adaptation and proper management of infrastructures. This includes for example the reforestation of watersheds and general incentives to promote more sustainable land use and activities also in non-agricultural areas.

Conclusions

Soil erosion, both for water and wind, is still a severe problem in Europe, where it takes place at different degrees in large areas. The regions with the greatest severity of soil loss are the Mediterranean, the Balkan Peninsula and the countries surrounding the Black Sea, where it may lead to desertification. They also include some of the new EU member states and accession countries.
Soil erosion in vulnerable soils is expected to further develop as climate is expected to change towards more frequent and high-intensity rainfalls with an increased erosivity of single events.
Unsustainable land use practices and in particular unsuitable agricultural practices can be identified as the main driving forces for soil erosion in the enlarged EU. Hence, on the one hand, the political and economic measures influencing agriculture such as the *Common Agricultural Policy (CAP)* and open market forces may lead to an increase of the risk of erosion. On the other hand, especially the CAP includes key elements to combat erosion. In particular, the CAP reform provides new possibilities to influence land management practices. Against the background provided by the CAP as well as by other policies and market forces, farm management practices at the single farm level could most directly be influenced by local scale measures, such as farm development schemes and farm advisory systems. As a consequence, regional and local policy developments have a high potential for combating soil erosion.

In the new EU countries and accession countries, soil erosion has been a problem for many decades and it remains significant today. The consequences for soil and water resources may be limited if we learn the lessons from the past and if the expected intensification in the agricultural sector is accompanied by improved management and the application of appropriate agri-environment measures.

Acknowledgements and remarks

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Coastal erosion in Europe

Results and recommendations from the EUROSION project

EUROSION is a project commissioned by the General Directorate Environment of the European Commission, which will result in policy recommendations on how to manage coastal erosion in Europe in the most sustainable way. One quarter of the European Union's coast is currently eroding despite the development of a wide range of measures to protect shorelines from eroding and flooding. The prospect of a further sea level rise due to the climate change and the heritage of mismanagement in the past - such as inappropriate infrastructure - implies that coastal erosion will be a growing concern in the future.

by Hugo Niesing (M Sc) & Niels Roode (M Sc), National Institute for Coastal and Marine Management (RIKZ), The Hague (NL)

Coastal erosion

Coastal erosion is the encroachment of land by the sea and is measured by averaging over a period, which is sufficiently long to eliminate the impacts of weather, storm events and local sediment dynamics.

Coastal erosion results in three different types of impacts (or risks):

- loss of land with economical value;
- destruction of natural sea defences (usually a dune system) as a result of a single storm event, which in turn results in the flooding of the hinterland and
- undermining of artificial sea defences potentially also leading to flood risk.

The processes of coastal erosion and accretion have always existed and have contributed throughout history to shape European coastal landscapes, creating a wide variety of coastal types. The erosion of inland soils induced by rainfall and the movement along riverbeds provides considerable amounts of terrestrial sediments to the coast in some areas. These sediments together with those derived from coastal features (such as eroding cliffs and marine sand banks) provide essential material for the development of offshore reefs, mud flats, saltmarshes, sandy beaches, sand dunes, and transitional marshes.

In turn, these coastal habitats provide a wide range of outstanding benefits including locations for economic and recreational activities, the protection from flooding in low lying areas, the absorption of wave energy during storm surges, the reduction of the eutrophication of coastal waters, the nesting and hatching of fauna species. Combating coastal erosion may create new problems elsewhere, depending on the type of measures taken.

Coastal erosion is usually the result of a combination of factors – both natural and human-induced – that operate on different levels. Most important natural factors are: winds and storms, near-shore currents, a relative sea level rise (a combination of vertical land movement and sea level rise) and slope processes. Human-induced factors of coastal erosion include: coastal engineering, land claim, river basis regulation works (especially the construction of dams), dredging, vegetation clearing, gas mining and water extraction.

The major findings of EUROSION

With regard to the underlying mechanisms responsible for the problems in the field of coastal erosion, EUROSION has identified the following major findings:

1. Finding on coastal squeeze and loss of sediment

Urbanisation of the coast has turned coastal erosion from a natural phenomenon into a problem of growing intensity. The majority of coastal erosion problems is now induced by human activities and artificially stabilised seafronts are progressively encroaching on sedimentary coastlines and cliffs. Dynamic ecosystems and their undeveloped coastal landscapes are gradually disappearing due to a lack of sediment. In many places the process of "coastal squeeze" is responsible for this phenomenon.

2. Finding on environmental and economic assessment

Environmental Impact Assessment (EIA) procedures have been insufficient in addressing the impact of human activities, such as development, on the wider coastal environment. Subsequently, the cost of attempting to reduce coastal erosion has increased considerably in relation to the assets requiring protection. Consequently, it has resulted in a need to transfer the cost of coastal erosion mitigation measures to such activities.

3. Finding on the coastal erosion risk

The cost of reducing coastal erosion risk is mainly supported by national or regional budgets, hardly ever by the local community and almost never by the owners of assets at risk or by the party responsible for coastal erosion. This is emphasized by the fact that coastal erosion risk assessment has not been incorporated in decision-making processes at the local level and that risk information to the public remains poor.

4. Finding on the mitigation of coastal erosion

Over the past hundred years the limited knowledge of coastal sediment transport processes at the local authority level has resulted in inappropriate measures of coastal erosion mitigation. In a considerable number of cases, measures may have solved coastal erosion locally but have exacerbated coastal erosion problems at other locations – up to tens of kilometres away – or have generated other environmental problems.

5. Finding on information management
In spite of the availability of a tremendous amount of data, information gaps continue to exist. Practices of coastal information management – from raw data acquisition to aggregated information dissemination - suffer from major shortcomings, which result in inadequate decisions. Surprisingly, the sharing and dissemination of coastal data, information, knowledge and experiences are hardly ever considered by regional and local stakeholders. The use of a better knowledge base when coastal development is proposed provides an opportunity, which might help to reduce the technical and environmental costs of human activities (including measures for coastal erosion mitigation) and to anticipate future trends and risks.

The EUROSION vision
1. The concept of coastal resilience
Understanding the dynamic nature of the coastal margin is a key factor in managing coastal erosion. EUROSION defines coastal resilience as the inherent ability of the coast to accommodate changes induced by sea level rise, extreme events and occasional human impacts whilst maintaining the functions fulfilled by the coastal system in the longer term. – The concept of resilience is particularly important in the light of the predictions for climate change. Resilience depends on two key factors: sediments and space for coastal processes.

2. Strategic sediment reservoirs
The need to counteract a negative sediment balance in a particular coastal zone will require a source of sediment to be identified. To facilitate the future availability of such an "appropriate" sediment supply, EUROSION proposes the concept of "strategic sediment reservoirs". These are defined as: supplies of sediment of "appropriate" characteristics that are available for the replenishment of the coastal zone, either temporarily (to compensate for losses due to extreme storms) or in the long term (at least 100 years). They can be identified offshore, in the coastal zone (both above and below low water) and in the hinterland. After the designation of strategic sediment reservoirs, their availability should be ensured by leaving them undeveloped.

EUROSION policy recommendations
On the basis of the findings and the EUROSION vision, four key recommendations are proposed that, once implemented as a package, will make coastal erosion problems and risks in Europe manageable. For each recommendation an indication of its implications is given at the level of the European Union, the Member States and the coastal regions (local government).

1. Increasing coastal resilience by restoring the sediment balance and providing space for coastal processes
A more strategic and proactive approach to coastal erosion is needed for a sustainable development of vulnerable coastal zones and for the conservation of coastal biodiversity. In the light of the climate change it is recommended that coastal resilience is enhanced by:
- restoring the sediment balance;
- allocating space necessary to accommodate natural erosion and coastal sediment processes and
- designing strategic sediment reservoirs.

Two examples of coastal erosion in Europe

Example of coastal cliff erosion
The soft-rock coastal cliffs near the village of *Happisburgh (North Norfolk, UK)* are suffering from wave-induced erosion at erratic rates: at times large areas have disappeared overnight and at others the cliff has remained virtually the same for some years. Villagers in Happisburgh gathered near the cliff-top to spell out a human SOS (behind the row of houses), as a plea to their national government to stop the village from crumbling away.

Example of coastal plain erosion
The *Camargue*, located in the Rhône delta, is a typical example of a coastal plain. It developed due to the interplay of Rhône sediments and the hydraulics forces of the Mediterranean. The sea level rise and a reduced sediment supply from the Rhône has accelerated coastal erosion since the 1900's. The picture illustrates the effect of a storm on coastal dunes, which is partly restored during the non-stormy season. At the long run, coastal erosion threatens the town of *Stes Maries de la Mer*, the tourism infrastructure and the salt pans located behind the coastal dunes.

In view of the importance of the availability of sediments and space for sediment transport (from rivers, along the shore and between the coastal system and the seabed) EUROSION proposes the concept of a "favourable sediment status" for coastal systems. This concept may help to form the basis for the shoreline and water catchment management. A favourable sediment status may be defined as the situation of "coastal sediments" that will permit or facilitate meeting the objective of supporting coastal resilience in general and of preserving dynamic coastlines in particular.

2. Internalising the coastal erosion cost and risk in planning and investment decisions

The impact, cost and risk of human induced coastal erosion should be controlled through a better internalisation of coastal erosion concerns in planning and investment decisions. The public responsibility for the coastal erosion risk (through the taxation system) should be limited and an appropriate part of the risk should be transferred to direct beneficiaries and investors. Environmental assessment instruments should be applied to achieve this. Risks should be monitored and mapped, evaluated and incorporated into planning and investment policies.

EUROSION does not propose to create new instruments but instead recommends to incorporate coastal erosion concerns (especially risk assessment) into the implementation of existing instruments at all levels of administration. These instruments include:

- environmental assessment;
- financial instruments; and
- Integrated Coastal Zone Management (ICZM).

3. Making responses to coastal erosion accountable

The coastal erosion management should move away from piecemeal solutions to a planned approach based upon accountability principles. These would help to optimise investment costs against values at risk, to increase the social acceptability of actions and to keep options open for the future. EUROSION proposes a more proactive approach based on the planning and accountability of achievements in the fields of coastal erosion management.

4. Strengthening the knowledge base of coastal erosion management and planning

The knowledge base of coastal erosion management and planning should be strengthened through the development of information governance strategies. These should be the starting point providing information on "best practices' (including learning from failures), for a proactive approach to data and information management and for an institutional leadership at the regional level. ■

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Europas Küsten von Erosion bedroht

Die europäischen Küsten sind zunehmend von Erosion bedroht. Etwa ein Fünftel der europäischen Küstenlinie ist vom Abtrag stark betroffen. Vielerorts gehen jährlich Küstenstreifen von einem halben bis zu zwei Metern Breite verloren, in dramatischen Fällen sogar bis zu 15 Meter breite Abschnitte. Das geht aus der EUROSION Studie hervor, die von der Europäischen Kommission in Auftrag gegeben worden ist.

Küstenschutz ganz oben auf der Agenda

Die natürliche Erosion der Küsten ist ein bekanntes Phänomen: Sand und Kies werden von Wellen und durch die Strömung weggespült. Die heute zu beobachtende Erosion ist aber nur zu einem kleineren Teil natürlichen Ursprungs. Weit verheerender wirken sich menschliches Handeln aus: Dadurch, dass jährlich 100 Millionen Tonnen Sand verbaut oder durch Befestigungen von Flussufern und Küstenabschnitten immobilisiert werden, ist die natürliche Resedimentierung, für die die Flüsse mit ihrer Schwebfracht von entscheidender Bedeutung sind, gestört. In den letzten Jahren haben zudem der steigende Meeresspiegel sowie die Zunahme von Stürmen und schweren Fluten die Problematik verschärft. Folgen der Küstenerosion sind große Landverluste von hohem ökologischen und ökonomischen Wert, der Verlust von Eigentum und die wachsende Bedrohung für die Küstenbewohner. Für die EU Kommission steht das Thema Küstenschutz daher für die Zukunft ganz oben auf der Agenda. Zukünftig sollen Projekte entlang von Flüssen und der Küste sehr viel genauer auf ihren Einfluss auf die Küstenerosion hin untersucht und ein aktives und nachhaltiges Küstenmanagement gefördert werden.

Das Erfordernis von ***Küstenschutzmaßnahmen*** ergibt vor allem aus der Nutzung des Küstenraumes, nämlich durch

- Maßnahmen zur mittel- oder langfristigen lokalen Reduzierung oder Verhinderung des Uferrückganges und des Landverlustes; und
- Maßnahmen zum Schutz vor Überschwemmungen bei Sturmfluten und vor Durchbrüchen von Nehrungen.

Aufgabe des Küstenschutzes ist es dabei, in Kenntnis und Anerkennung der natürlichen Küstenentwicklung diese so wenig und so naturnah wie möglich zu beeinflussen; jedoch so, daß vitale menschliche Interessen gewahrt bleiben.

Shoreline Management of the Wadden Sea Islands

Example of a EUROSION Case Study

by Peter Schoeman, National Institute for Coastal and Marine Management (RIKZ), The Netherlands

Introduction / Problem

The Wadden Islands are a chain of barrier islands in front of the Dutch coast. Dikes protect the inhabited parts of the islands. The uninhabited parts of the islands are not artificially protected and therefore subject to natural processes. The shores of the islands show erosion and accretion in different places. There are also many different trends over time in erosion and sedimentation.

The cause of the structural erosion is mainly due to *sea level rise*: the tidal flats grow with sea level and import into the Wadden Sea increases. Acute erosion can also occur in a case of a severe storm.

Erosion along the North Sea coast causes a *high risk of flooding*. Firstly, erosion is a threat for natural areas: dunes and salt marshes. These are generally being seen as more important: if dunes disappear, urban areas are being threatened, as are houses built for recreational and tourism purposes. For the local people, tourism and recreation is the main source of income. The policy option is called dynamic preservation in the Netherlands, because, where possible (from a safety point of view), maximum freedom is offered for natural processes.

Effect cross-shore dam at island Textel before 1994

Policy and Measures

The policy option is called dynamic preservation in the Netherlands, because where possible (from safety point of view) maximum freedom is offered for natural processes. The engineering options are both soft and hard. The strategy is to work as much as possible with natural processes. The tools and methods used are described in *Coastline management, from coastal monitoring to sand nourishment* (RIKZ, 1996). To stop the structural erosion the main measure is nourishing. Both shoreface and beach nourishments are used. For an evaluation of shoreface nourishments, see the NOURTEC, 1996).

Results and Impact

- Structural erosion did not stop. Negative effects of erosion of the islands has been almost nullified by nourishments and local erosion resistant structures.
- At some places at the Wadden Sea side, channel migration towards the coast was stopped with revetments. The coastline was preserved, but erosion did not stop and in the end the construction was damaged. It shows that structural erosion cannot be stopped with hard constructions.
- The chosen coastal protection meets the main purpose of the Wadden Sea (protection and development of the Wadden area as nature area and preservation of the open landscape). Other coastal defence measures than nourishments would not meet this purpose. The Wadden Sea is and will be preserved because it can fill in with sand.

Conclusions and Tasks for Future

- Nourishments have shown to be effective.
- Constructions have stopped local erosion of the coastline, but constructions always need maintenance.
- Profound knowledge of the system is absolutely necessary to succesfully apply hard constructions.
- The demarcation of a broad sea defence zone permits closer integration of functions in the dune area and in particular offers opportunities for encouraging the play of natural dynamic forces.
- The filling in of the Wadden Sea can only be evaluated after a long term period of some 50 years. ■

Effect cross-shore dam at island Textel after 1999

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Implementation of the United Nations Convention to Combat Desertification (UNCCD) in Central Asian states

The Central Asian region, which includes Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan shares a common cultural and historical development. It is a classical example of an arid and sub-arid region characterized by serious cross-border problems of desertification. Central Asia is an enormous closed-drainage basin, with the Aral and Caspian Seas and the Lake Balkhash. During the past 50 years, the natural resources of the Aral Sea Basin have suffered considerably from human influence and the progressive development of desertification processes. The state of the environment in the region is largely determined by the disastrous changes taking place in the Aral Sea Basin.

by Mikhail Outkine, UN Secretariat for the Convention to Combat Desertification, Bonn (D)

In 1960, the Aral Sea was the world's fourth largest sea in terms of water area. In the past 40 years, it has shrunk considerably, losing 80 percent of its original volume and over 60 percent of its surface area. In addition, the redistribution of water resources in the region resulted in many other unexpected environmental consequences.
Taking into account these and some other socio-economic factors, all Central Asian states became Parties to the UNCCD, which entered into force in December 1996 and at present comprises 190 states and the European Union. Pursuant to the provisions of the UNCCD country, Parties to the Convention, which are affected by desertification, are requested to prepare *National Action Programmes (NAPs)* to combat desertification. By the year 2001, such programmes have been prepared and adopted in all Central Asian states.

The purpose of NAPs is to identify the factors contributing to desertification and practical measures necessary to combat desertification and to mitigate the effects of drought. At the same time, NAPs take into account specific conditions of each country and relevant priority tasks.

In *Kazakhstan*, the principal aim of the NAP is to combat desertification, as one of the prerequisites for sustainable development and to improve the welfare of the people, through reclamation of degraded lands, restoration of soil productivity, sustainable management of land resources.

In *Kyrgyzstan*, the NAP aims at increasing the role of local communities in combating desertification and poverty alleviation, in conserving mountain ecosystems and biodiversity, in developing of ecotourism, in having control over erosion processes, salinization and water logging, in increasing forest areas, in ensuring the sustainable management of rangelands and in watershed areas.

The principal aims of the NAP of *Tajikistan* are the improvement of ecological conditions in the irrigated area, the preservation of the biodiversity of mountain ecosystems, the creation of year-round pastures, the use of alternative energy sources, the preservation and expansion of areas of mountainous forests.

In *Turkmenistan*, the NAP aims at the development of a National Monitoring System, the creation of year-round pastures, the stabilization and afforestation of moving sands, the conservation and restoration of forests, the development and use of wind and solar power generators.

Uzbekistan in its NAP aims at mitigating the effects of drought, combating the degradation of irrigated lands and secondary salinization, afforesting the dried bottom of the Aral Sea, rationally using water resources. These NAPs are at different stages of implementation.

Their texts could be found on the UNCCD website www.unccd.int.

Areas affected by soil erosion in Central Asia

Areas affected by overgrazing in Turkmenistan ...
Photo: Andrey Aranbaev

... and in Uzbekistan
Photo: Oleg Tsaruk

The action programmes to combat desertification

In accordance with the provisions of the Convention, affected country Parties may also prepare *Sub-regional Action Programmes to Combat Desertification (SRAP/CD)* in order to harmonize, complement and increase the efficiency of NAPs. Since desertification and drought are often cross-border problems which require joint action, the Central Asian states took a decision in 2000 to develop a SRAP/CD within the UNCCD context. In 2003, the text of the SRAP/CD was finalized and adopted by the Ministers from Central Asian states. The areas of sub-regional cooperation outlined below constitute the *framework for the implementation* of joint and/or national pilot projects under the SRAP/CD:

Monitoring and evaluation of desertification processes; establishment of an early warning system for drought and drought mitigation.
The establishment of this system will be based on a common database. National geographic information systems for environmental monitoring, which exist or are under development, will be the basis for establishing such a system.

Improvement of water use in agriculture; combating erosion, salinization, and swamp formation.
Joint action will be aimed at improving the efficiency of water use, cultivating plants with lower water consumption and salt-resistant plants and at restoring the drainage system.

Agroforestry and management of forest resources and watersheds.
Joint actions will aim at reducing and halting the process of deforestation and at developing, introducing and improving afforestation and agroforestry technologies.

Pasture management.
The introduction of private-owned farms requires special scientific research. The main goal in this area will be a sustainable pasture management, which means to increase the livestock productivity and to conserve pastures.

Conservation of biodiversity and nature protection; development of eco- and ethno-tourism.
Joint actions will be aimed at assessing the intensity of transformation processes, revealing urgent problems and at developing and implementing appropriate strategies.

Economic capacity building of local communities.
Joint actions will include the development and exchange of experience in alternative sources of income, the research into alternative sources of energy; the exchange of experience in stimulating the economic development of rural communities, the exchange of information on potential markets for agricultural products.

The principal instruments for solving sub-regional problems include: *national and sub-regional pilot projects, training courses, scientific cooperation and information exchange.*

The strategie for implementation

The strategy for implementation of the SRAP/CD is based on the fact that at the initial phase, *national pilot projects* will be prepared and implemented in priority areas of sub-regional cooperation. They will be closely tied to NAP implementation. At the second phase, as experience is gained in implementing national pilot projects, they will be replicated in other Central Asian countries making them sub-regional. The following *sub-regional projects* will be considered as projects of highest priority:

- development of a drought early warning system;
- preparation of a desertification map of Central Asia;
- efficient use of land, water and pasture resources;
- stabilization and afforestation of shifting dunes;
- conservation of mountainous ecosystems;
- restoration and improvement of degraded forest and pasture lands;
- creation of protected cross-border territories.

The organization of *training courses* is an important tool for the UNCCD implementation. The scientific and research institutions, field stations of Central Asian countries will be activated for organizing training courses, in particular on the utilization of GIS technologies, the sustainable management of eroded slope land and pastures, the rehabilitation of forests and the control of soil erosion in mountainous areas, the fixation and afforestation of moving sands. The training potential of international organizations and developed partner countries will also be used. Within the framework of the SRAP/CD the Central Asian states agreed to develop a *scientific cooperation* in particular through the coordination of the process of gathering and analysing scientific data, the selection of research topics under identified priority areas, the transfer and exchange of technologies, in particular traditional knowledge and know-how, the preparation of joint publications. Effective regional cooperation demands the organization of a properly functioning mechanism of information exchange. Joint actions in this direction will include the publication of the magazine "*Problems of Desert Development*" and of an online bulletin *"Central Asia: problems of desertification"*, the development of a system of internet web sites, the creation of a thematic information server and/or of a special internet forum, the preparation of methodological guidelines and the production of video films.
It is intended that non-governmental organizations and local communities will play an important role implementing NAPs and the SRAP/CD by providing a link between governmental structures and the local population.
Financial resources for NAPs and the SRAP/CD implementation will be mobilized from various sources, both national (budgetary and private) and international ones.
■

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Risikogerechte Raumnutzung zur Prävention von Naturgefahren im Alpenraum

Eine Analyse der Naturgefahrenprävention in den Alpen

In großen Teilen des Alpenraums kam es in den Jahren 1999 und 2000 zu verheerenden Überschwemmungen, Murgängen und Rutschungen. Diese forderten insgesamt 73 Todesopfer und verursachten Sachschäden sowie wirtschaftliche Folgekosten in Milliardenhöhe. Im Auftrag der Alpenkonferenz analysierte eine Arbeitsgruppe diese Ereignisse mit dem Ziel, Maßnahmen für die künftige Präventionsarbeit aufzuzeigen. Einige Resultate dieser Analyse werden hier präsentiert.

von Andreas Götz, Geschäftsführer der Internationalen Alpenschutzkommission CIPRA & Felix Hahn, CIPRA, Schaan (FL)

Realität und gesellschaftliche Ansprüche

Im Alpenraum ist der Mensch den Naturgewalten seit jeher stark ausgesetzt. Als Folge einer immer intensiveren Nutzung – auch von Gebieten, welche früher als Risikozonen galten – nimmt jedoch das Schadenpotenzial laufend zu. Nach heutigen Erkenntnissen ist damit zu rechnen, dass die nachgewiesene Klimaerwärmung (ob anthropogen bedingt oder nicht) extreme Windstärken und mehr Starkniederschläge mit sich bringt. Hochwasser werden im Winter und in den Übergangszeiten an Intensität gewinnen, wobei die Situation durch die zunehmende Bodenversiegelung noch verschärft wird.

Mit den steigenden Schaden- und Gefahrenpotenzialen wachsen auch die gesellschaftlichen Sicherheitsansprüche. Dies ist zumindest teilweise auf die Perfektionierung der öffentlichen Dienstleistungen im Zusammenhang mit Naturgefahren (Versicherungswesen, Naturkatastrophenfonds, freiwillige Hilfswerke) zurückzuführen. Mag das Individuum im Einzelfall bewusst große Risiken eingehen, im Kollektiv dominiert der Ruf nach staatlich garantierter, praktisch lückenloser Sicherheit. Beispielsweise werden heute auch im Alpenraum Verkehrswege verlangt, die ungeachtet der schwierigen klimatischen und topographischen Rahmenbedingungen rund um die Uhr während des ganzen Jahres gefahrlos befahren werden können. Der Staat stößt hier an Grenzen der Realisierbarkeit.

Verschüttung einer Landstraße im Engadin, Schweiz durch Erdrutsch. Photo: R.D. Jenny

Handlungsbedarf zur Verbesserung der Gefahrenprävention

Die jüngsten Unwetterereignisse der Jahre 2001 und 2002 und ihre Folgen haben nochmals unterstrichen, dass in den Alpenstaaten ein Handlungsbedarf bei der Naturgefahrenprävention besteht. Die Arbeitsgruppe der Alpenkonferenz fordert eine ausgewogene *Kombination verschiedener Präventionsmaßnahmen*.

Grundsätzlich gilt es, *die Raumnutzung künftig besser den bestehenden Naturgefahren anzupassen und gefährdete Gebiete möglichst zu meiden*. Hierfür muss die Gefahrenbeurteilung und -analyse verbessert werden. Eine Steigerung der Prognosegenauigkeit und eine Verlängerung der Vorwarnzeit ist anzustreben. *Gefahrenkarten mit Angaben über die Gefahrenpotenziale* durch Hochwasser, Murgänge, Rutschungen, Felssturz, Steinschlag etc. sind für alle raumnutzungsrelevanten Planungen unerlässlich. Ihre Effizienz hat sich bei der Minimierung von Lawinenschäden klar bestätigt. Insbesondere wegen dem Klimawandel und der immer intensiveren Nutzung des Alpenraumes sollten sowohl die Gefahrensituation als auch die entsprechenden Vorsichtsmaßnahmen ständig überprüft werden.

Aktiver Schutz vor Naturgefahren – wie beispielsweise der bauliche Hochwasserschutz – ist teuer, schadenempfindlich und von begrenzter Lebensdauer. *Die risikogerechte Raumnutzung sowie der Unterhalt bestehender Schutzbauten haben höhere Priorität als der Bau neuer Schutzanlagen.* In Risikogebieten helfen konkrete Maßnahmen des Objektschutzes (gut gesicherte Öltanks, etc.) wie auch eine verbesserte Notfallplanung das Schadensausmaß wirksam zu mildern. Natürliche Retentionsräume für Fließgewässer, Schutzwälder oder eine geschickte Wasserbewirtschaftung machen aufwändige bauliche Maßnahmen oftmals überflüssig. Im Krisenfall sind eine rasche, umfassende Kommunikation in den Krisenstäben und eine der Situation angepasste Information der Bevölkerung von entscheidender Bedeutung. Die Medien müssen gezielt und effizient in den Informationsfluss eingebunden werden. Auch der Forschung kommt weiterhin eine hohe Bedeutung zu. Nicht zuletzt müssen in unserer Gesellschaft die Wahrnehmung, das *Bewusstsein und die Akzeptanz von (Rest-) Risiken* im Rahmen eines Risikodialogs vermehrt thematisiert werden.

Das Spannungsfeld zwischen risikogerechter Landnutzung, rücksichtsloser Übernutzung und absoluten Schutzansprüchen erfordert einen permanenten Interessenausgleich, der nur in einer demokratischen Auseinandersetzung zwischen allen Beteiligten möglich ist.

Schlussfolgerungen für die Zukunft
Es ist wichtig, die von den Naturgefahren ausgehenden Risiken sowie deren Entwicklung für den Menschen und dessen Infrastruktur frühzeitig zu erkennen. Obwohl der Wert aller Schutzbauten im Alpenraum mehrere 100 Milliarden Euro beträgt, kann ein absoluter Schutz vor Naturgefahren nicht garantiert werden. Zudem stößt die technische Machbarkeit immer öfters an ökonomische und ökologische Grenzen, welche die Möglichkeiten der Risikoreduktion beschränken. Ein ausgewogener Schutz vor Naturgefahren muss neben technischen verstärkt auch wirtschaftliche, soziale und ökologische Kriterien berücksichtigen. Schlüsselrollen kommen dabei der Land- und der Forstwirtschaft zu. Zum einen schaffen sie Arbeitsplätze und zum andern tragen sie entscheidend zur Landschaftsgestaltung und zur Sicherung ganzer Talschaften und Einzugsgebiete bei. Darüber hinaus muss unsere Gesellschaft in erhöhtem Maße lernen, mit Risiken umzugehen. Die bisherige Aufgabenteilung zwischen Privaten, Staat, Versicherungen und Hilfswerken gilt es zu überdenken. So sollten Grundeigentümer bei der Nutzung gefährdeter Grundstücke mehr Eigenverantwortung übernehmen als dies heute zumeist der Fall ist - Eigenverantwortung wird in Zukunft wieder wichtiger. Jedoch erfordert die erhöhte Anfälligkeit der Berggebiete für Naturgefahren auch weiterhin die Solidarität zwischen Geschädigten und Nichtbetroffenen in den risikoärmeren Gebieten des Flachlands. Schließlich sollte *die internationale Zusammenarbeit wo immer möglich intensiviert werden*. Unabhängig von der Risikosituation und dem Sicherheitsniveau können die Alpenländer vom gegenseitigen Erfahrungsaustausch bei ihrer Präventionsarbeit profitieren. Prüfung und gemeinsame Weiterentwicklung von nachhaltigen Schutzkonzepten und international vergleichbare Sicherheitsstandards sind anzustreben. Fragen wie die folgenden müssen länderübergreifend diskutiert werden:

- *Sind die Grenzen des Wachstums und der Belastung im Alpenraum erreicht?*
- *Was sind gerechtfertigte Sicherheitsansprüche zum Schutz vor Naturgefahren, die staatlich gefördert werden müssen?*
- *Wie kann die Raumplanung und die Landnutzung in Zukunft noch naturgefahrenkonformer gestaltet werden?*
- *Wie kann ein gesamtheitlicher Risikodialog gefördert werden?*

Die Alpenkonvention bietet eine ausgezeichnete Grundlage, um die Zusammenarbeit und den Erfahrungsaustausch zum Schutz vor Naturgefahren über die Landesgrenzen hinweg auf Forschungs-, Verwaltungs- und Praxisebene zu fördern. ■

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Bundesamt für Umwelt, Wald und Landschaft BUWAL (2003): Unwetterereignisse im Alpenraum, Bern.

Summary
The Alpine Space has a need for action to improve the prevention of natural hazards. This is one of the conclusions drawn by an international working group which discussed the natural hazards issue on behalf of the Alpine Conference. It demands a balanced combination of different preventive measures, in which an adequate spatial use should play a central role in the future. The Alpine Convention provides an excellent basis to promote the international cooperation and the exchange of experience to prevent natural hazards.

Die gemeinsamen Ziele der Alpenländer beim Bodenschutz – das Bodenschutzprotokoll der Alpenkonvention

Der Boden ist ein wertvolles Gut. Darüber herrscht in den Alpenländern Einigkeit. Zudem hat sich die Einsicht durchgesetzt, dass Bodenschutz wo möglich fach-, bereichs- und auch grenzübergreifend praktiziert werden sollte. Um den angestrebten schonenden und sparsamen Umgang mit der Ressource Boden alpenweit zu fördern, wurde am 16. Oktober 1998 in Bled (SLO) das *Ausführungsprotokoll „Bodenschutz“ der Alpenkonvention* von den Vertragsstaaten (Monaco, Frankreich, Italien, Schweiz, Deutschland, Liechtenstein, Österreich, Slowenien) unterzeichnet.

Oberstes Ziel des Protokolls ist es, die ökologischen Bodenfunktionen als wesentlichen Bestandteil des Naturhaushalts langfristig qualitativ und quantitativ zu erhalten und die Wiederherstellung beeinträchtigter Böden zu fördern. Ebenfalls will das Protokoll den Boden als Archiv der Natur- und Kunstgeschichte schützen sowie seine Nutzung durch den Menschen sicherstellen. Die im Alpenraum typische Vielfalt der Böden und charakteristischen Standorte soll bewahrt und gefördert werden.

Dem *Vorsorgeprinzip* kommt gemäß Protokoll eine zentrale Bedeutung zu. Rechtliche und administrative sowie fiskalische und finanzielle Maßnahmen sollen helfen, eine umweltschonende Bodennutzung in den Alpen zu fördern und durchzusetzen. Besteht die Gefahr schwerwiegender und nachhaltiger Beeinträchtigungen der Funktionsfähigkeit der Böden, so ist grundsätzlich den Schutzaspekten Vorrang vor den Nutzaspekten einzuräumen.

Die von den Vertragsparteien ermittelten *spezifischen Maßnahmen* zielen insbesondere auf eine standortgerechte Bodennutzung, einen sparsamen Umgang mit der Fläche, die Vermeidung von Erosion und nachteiligen Veränderungen der Bodenstruktur sowie auf Minimierung der Einträge von bodenbelastenden Stoffen. Spezieller Wert wird auf die Erhaltung der Böden in Feuchtgebieten und Mooren gelegt.

Nicht zuletzt wird im Protokoll gefordert, die Anstrengungen bei Forschung, Bildung und Information zu koordinieren und harmonisierte Datengrundlagen zu schaffen. Ein alpenweites *Bodenschutz-Monitoring* wird angestrebt.

Bodenschutz ist ein wichtiges Thema. Alleine in der Schweiz wird beispielsweise jede Sekunde nahezu ein Quadratmeter Boden umgestaltet. Bis heute wurde das Protokoll jedoch erst von Österreich, Deutschland, Monaco und Liechtenstein ratifiziert. Seine Umsetzung steckt noch in den Kinderschuhen.

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Aspekte des Einsatzes von Pflanzen gegen Erosion und Rutschungen in der Schweiz

Wie andere Gebirgsregionen ist auch die Schweiz immer wieder von Unwetterereignissen betroffen. Durch starke Regenfälle kommt es dabei in steilen Einzugsgebieten oft zu oberflächennahen Rutschungen, und Hochwasserabflüsse bewirken Erosions- und Rutschprozesse entlang der Bachläufe. Starke Geschiebeführung und Schwemmholztransport sind die Folgen. Dadurch entsteht die Gefahr von Verklausungen und Gerinneausbrüchen, welche in besiedelten Gebieten häufig zu großen Schäden führen. Verschiedene Maßnahmen tragen dazu bei, diese Probleme zu mindern (BWG 2001). Dazu gehören einerseits eine an die Gefahrensituation angepasste Raumnutzung und – wo nötig – technische Schutzmaßnahmen. Andererseits sind auch Maßnahmen im Zusammenhang mit der Schutzwirkung der Vegetation von grundlegender Bedeutung. Dabei sind die folgenden zwei Ziele zentral: a) Erhaltung und Pflege einer wirkungsvollen und widerstandskräftigen Vegetationsdecke gegenüber Erosions- und Rutschprozessen (z.B. Schutzwald); b) Wiederbepflanzung und Etablierung einer nachhaltig stabilen Pflanzengesellschaft auf Erosionsflächen nach Unwetterereignissen.

von Christian Rickli & Frank Graf, Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft WSL, Abteilung Wasser-, Erd- und Felsbewegungen, Forschungsbereich Naturgefahren, Birmensdorf (CH)

Wirkung und Pflege des Schutzwaldes
Einem stabilen Schutzwald wird schon seit langem eine gute *Wirkung gegenüber Rutsch- und Erosionsprozessen* attestiert. Allerdings gibt es nur wenige Untersuchungen, welche diese Wirkungen quantifizieren. Die Analyse eines Unwetterereignisses aus dem Jahre 1997 in den Schweizer Alpen zeigte erstmals quantitativ auf, dass auf vergleichbaren Standorten und bis zu Hangneigungen von ca. 40° im Wald weniger Rutschungen entstanden als im Freiland. Im weiteren war auch der Zustand des Waldes von großer Bedeutung.

Oberflächennahe Rutschprozesse aufgrund von Starkniederschlägen 1997 in Sachseln, Schweiz. Foto: Amt für Wald und Landschaft, Obwalden

Während in Wäldern mit an die Standortsverhältnisse angepassten Baumarten und wenig Bestandeslücken nur wenig Rutschungen zu beobachten waren, fanden auf Flächen mit schlechtem Waldzustand (z.B. geschädigt durch Borkenkäfer und Windwurf) intensive Hangprozesse statt (Rickli et al. 2001).

Diese Ergebnisse sind ein Hinweis darauf, dass mit *waldbaulichen Pflegemaßnahmen* ein wesentlicher Beitrag zur Förderung der Sicherheit gegenüber oberflächennahen Rutschungen und Erosion geleistet werden kann. Um die Forstleute in ihren Entscheidungen zu unterstützen, wurden in der Schweiz Konzepte zur Beurteilung und Pflege der Schutzwälder in Abhängigkeit der vorherrschenden Naturgefahren erarbeitet, welche jeweils an den neuesten Stand der Forschung angepasst werden (Thormann und Schwitter 2004).

Wiederbepflanzung von Erosionsflächen
Ein vordringliches Ziel bei der *Stabilisierung von Rutschhängen und Erosionszonen* besteht in deren nachhaltigen Wiederbepflanzung. Die Initialpflanzung hat so zu erfolgen, dass natürliche Sukzessionsprozesse zur angestrebten Schlussgesellschaft führen und somit die Unterhaltsarbeiten auf ein Minimum reduziert werden können. Damit die Pflanzen ihre Schutzfunktionen entfalten, müssen sie wachsen und sich etablieren können. Dazu braucht es ein gewisses Maß an Bodenstabilität sowie ein minimales Wasser- und Nährstoffangebot (Graf & Gerber 1997).

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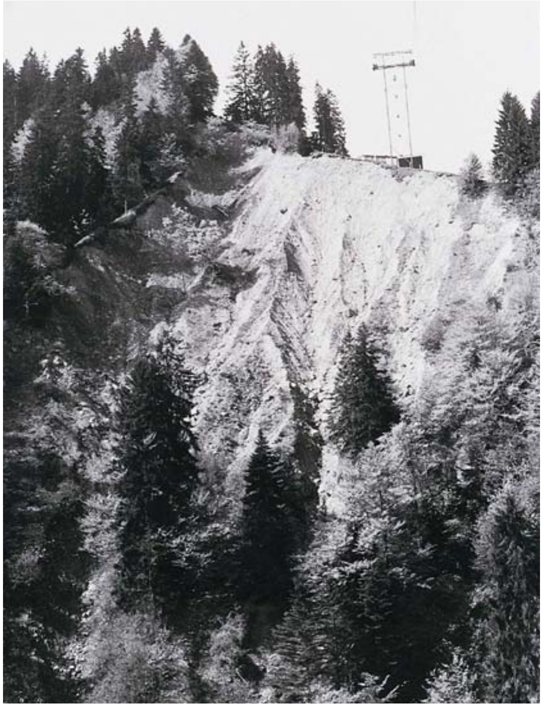

Der Weg von der kahlen Rutschungsfläche über die Pioniervegetation bis zur eigentlichen stabilen Zielvegetation dauert Jahre bis Jahrzehnte (links: Zustand 1974, rechts: Zustand 1989).

The process from the bald plane of slip via pioneer vegetation to a stabile target vegetation takes years to decades (left: the state of 1974, right: the state of 1989). Photos: WSL

Technische Verbaumaßnahmen, welche häufig unumgänglich sind (Hangfuß-Sicherung, Reduktion der lokalen Hangneigung, Entwässerung, etc.) sowie Methoden zur Förderung des Anwuchserfolges (Klebstoffe, Dünger) sollen daher von Anbeginn auf die nachhaltige Wiederbepflanzung hin ausgerichtet sein und haben der Verbesserung der Standortbedingungen zu dienen.

Insbesondere die Düngung kann sich jedoch negativ auswirken (Wiemken et al. 1997). Nährstoffbedürftige Pflanzenarten werden anstelle autochthoner Pioniere, die oberirdische Biomasse auf Kosten der Wurzeln gefördert. Zusätzlich kann es zu einer Abnahme der Artenvielfalt und der Symbiosebildung zwischen Pflanzen und Pilzen (Mykorrhiza) kommen, was negative Folgen für die Bodenaggregatbildung und Pflanzenernährung hat.
Während der Initialphase ingenieurbiologischer Maßnahmen beschleunigt die Verwendung von Mykorrhizapilzen die Bildung von Bodenaggregaten und dadurch die Bodenstabilität, was gleichzeitig die Nährstoffsituation verbessert (Frei et al. 2002). Als *„Bodenbauer“* und *„Pflanzenernährer“* nehmen die Mykorrhizapilze zudem unmittelbaren Einfluss auf die Entwicklung und *Diversität der Pflanzengemeinschaften*. Diese Prozesse tragen zur langfristigen Schutzwirkung der Vegetation bei und reduzieren die Unterhaltsarbeiten. Wie bei den Pflanzen ist auch bei der Auswahl der Pilze darauf zu achten, dass nur standortgerechte Arten eingesetzt werden.
Damit eine angestrebte Pflanzengesellschaft die ihr zugedachten ingenieurbiologischen Funktionen langfristig erfüllen kann, sind in den meisten Fällen Unterhaltsarbeiten unumgänglich. Ist dabei das Ziel eine Waldgesellschaft, beinhalten diese insbesondere die Regulierung der Mischung, die Förderung der Stufigkeit sowie *Maßnahmen zur Unterstützung der Verjüngung* (Graf et al. 2003). ■

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Summary

Like other mountainous regions, Switzerland as well is repeatedly affected by storms. Intensive rainfalls often lead to surface slides and flood runoffs result in erosion and slide processes along the water courses. The wedging of floating material and waterway runoffs often cause large damages in populated areas. Various measures contribute to reducing these problems (BWG 2001). They include a spatial use adapted to the risk situation on the one hand and – where necessary – technical preventive measures. On the other hand, measures related with the protective effect of vegetation are of basic importance: a) preservation and maintenance of a plant cover being effective and resistant towards erosion and slide processes (e.g. protective forest); b) replanting and establishment of a sustainable stabile phytocenosis on erosion areas following storms.

Naturgefahrenkartierung im Fürstentum Liechtenstein

Rhein, Rüfen (Muren) und Föhn galten in Liechtenstein seit Jahrhunderten als die drei Landesnöte. Die rasante Entwicklung des Landes während der letzten Jahrzehnte erhöhte die Intensität der Landschaftsnutzung und damit die Bedeutung der Naturgefahren enorm. Mit der flächendeckenden Naturgefahrenkartierung wurde eine wichtige Grundlage für die weitere Raumentwicklung geschaffen. Im Folgenden werden Vorgehensweise und Bedeutung dieser Arbeit vorgestellt.

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Ausgangslage

Liechtenstein als Kleinstaat von 160 km^2 Fläche liegt an der östlichen Talflanke des Alpenrheins zwischen 430 und 2.600 m ü/M. Die Rheintalebene als Hauptsiedlungsraum der 33.000 Einwohner, die steilen rheintalseitigen Hanglagen sowie das zunehmend als Erholungsraum genutzte Alpengebiet beanspruchen je 1/3 der Landesfläche. Die geologischen, topografischen und klimatischen Verhältnisse bilden günstige Voraussetzungen für das Wirken verschiedener Gefahrenprozesse.

Insbesondere die gravitativen Naturgefahren (Wasser, Steinschlag, Rutschungen und Lawinen) prägten deshalb die Besiedelung und Nutzung des Landes seit frühester Zeit. Während der letzten 50 Jahre erhöhte die enorme wirtschaftliche Entwicklung Liechtensteins mit entsprechender Bevölkerungszunahme die Problematik der Naturgefahren rasant. In jüngster Zeit lässt die *Häufung von Extremereignissen* befürchten, dass die anthropogen bedingten Beeinträchtigungen der Umwelt auch in Zukunft zu einem Anstieg der Konflikte führen werden. Primär ist jedoch weniger das Gefahrenpotenzial angewachsen, sondern das *Schadenpotenzial hat sich markant erhöht.*

Murgang im Gebiet der Gemeinde Triesenberg. Foto: AWNL

Ziel und Zweck

Die heutige intensive Landnutzung und die stark reduzierte Risikoakzeptanz der Bevölkerung erfordern umfassende Kenntnisse über die Naturgefahrensituation. Auf der rechtlichen Basis des Waldgesetzes beauftragte deshalb die Regierung im Jahre 1993 die zuständigen Amtstellen (Amt für Wald, Natur und Landschaft, Tiefbauamt, Landesplanung usw.) mit der Erstellung einer *landesweiten Naturgefahrenkarte* als objektiver Darstellung der gravitativen Gefahrenprozesse und ihrer Wirkungsweise. Diese ist behördenverbindlich und soll bei allen raumrelevanten Tätigkeiten berücksichtigt werden.

Kartierungsablauf

In enger Zusammenarbeit mit den Fachleuten der schweizerischen Forschungsanstalt für Wald, Schnee und Landschaft wurde ein Kartierungskonzept evaluiert, welches in den Jahren 1996 bis 2001 umgesetzt wurde und sich in die folgenden *Arbeitsschritte* aufteilt:

1. *Bestimmung der Kartierungseinheiten:* Die Hoheitsgebiete der Gemeinden resp. die gefahrenspezifisch zusammengehörigen Geländekammern wurden in neun geografische Einheiten unterteilt. Jede dieser Flächen wurde separat kartiert.

2. *Aufteilung der einzelnen Gebietskategorien:* Die Intensität der Beurteilung und die Bearbeitungstiefe kann aus zeitlichen und finanziellen Gründen nicht auf der gesamten Landesfläche einheitlich sein. Deshalb wurden folgende drei Gebietskategorien ausgeschieden:
   - Siedlungs- und Industriegebiete (intensive Geländekartierungen, Berechnungen, Simulationen / Unterteilung in vier Gefahrenstufen).
   - Forst-, land- und alpwirtschaftlich genutzte Gebiete (Übersichtsbegehungen / Pauschalgefällsberechnungen / drei Gefahrenstufen).
   - Naturlandschaften ohne forst- und landwirtschaftliche Nutzung (eine Gefahrenstufe).

3. *Erstellen eines Ereignis- und Projektkatasters* für jeden der vier Gefahrenprozesse aufgrund von Nachforschungen in Archiven und Befragungen von Gewährsleuten.

4. *Ausarbeitung geomorphologischer Grundlagenkarten* anhand von Geländebegehungen.

5. *Durchführen von Berechnungen und Modellbetrachtungen.*

6. *Gesamtheitliche Beurteilung der Gefahrensituation* aus den Informationen der prozessbezogenen Arbeitsschritte 3 bis 5.

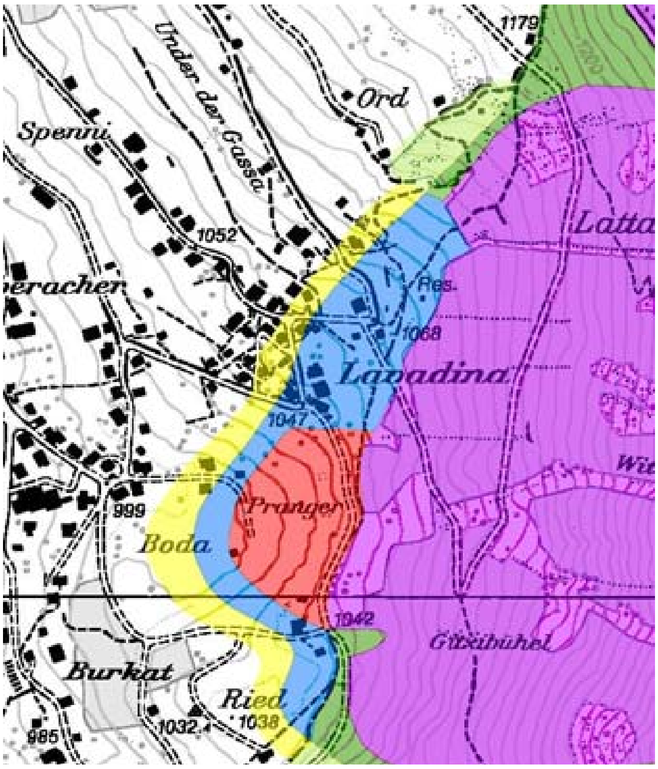
7. *Erstellen der Gefahrenkarten für jeden einzelnen Prozess sowie einer synoptischen Darstellung aller Prozesse.* Das Maß der „Gefährlichkeit“ eines Ereignisses wird als Ergebnis von Intensität und Wahrscheinlichkeit definiert und die einzelnen Teilflächen den verschiedenen Gefahrenstufen (erhebliche, mittlere, geringe Gefahr) zugeordnet. Die Darstellung auf den Karten erfolgt mittels Farbabstufungen, die sich in den drei Gebietskategorien unterscheiden.

8. *Ausarbeitung eines umfassenden Gefahrenberichtes* mit nachvollziehbarer Erläuterung der Kartierungsergebnisse.

9. Der rasche Landschaftswandel einerseits aber auch die sich laufend verbessernden Erkenntnisse über die einzelnen Gefahrenprozesse andererseits erfordern eine *laufende Nachführung der Karten.*

Anwendungen und Erfahrungen mit der Naturgefahrenkarte

Seitdem im März 1998 die Naturgefahrenkartierung der ersten Teilfläche abgeschlossen wurde, konnte dieses Instrument in verschiedenen Anwendungsbereichen eingesetzt und dessen Nutzen beurteilt werden. Dabei zeigt sich die Vielfalt der Anwendungsmöglichkeiten ebenso wie deren Grenzen.



Naturgefahrenkarte Sturzgefahr, Ausschnitt Triesenberg. Abbildung: AWNL

Bauzonenplanung / Behandlung von Baugesuchen

Die Bedeutung der Gefahrenstufen auf die Überbaubarkeit einer Fläche kann vereinfacht wie folgt definiert werden:

- *Rotes Gebiet* / Erhebliche Gefahr: generelles Bauverbot, keine Neubauten, bestehende Bauten können sachgerecht unterhalten werden, ohne aber die Nutzung zu vergrössern.
- *Blaues Gebiet* / mittlere Gefahr: Unter Einhaltung von Auflagen ist das Bauen im bestehenden Siedlungsgebiet grundsätzlich erlaubt.
- *Gelbes Gebiet* / geringe Gefahr: Bauwerber werden auf diese minimale Gefährdung hingewiesen. Konkrete Maßnahmen von Seite der Behörden sind nicht vorgesehen.

Bei der Ausscheidung der Bauzonen sind daher „Rote Gebiete“ auszusparen und „Blaue“ soweit möglich zu meiden. Baugesuche, welche in Liechtenstein zentral über die Landesverwaltung begutachtet resp. bewilligt werden, müssen, sofern die beanspruchten Grundstücke in einem entsprechenden Gefahrengebiet liegen, vom zuständigen Gefahrenspezialisten beurteilt werden. Dieser formuliert nötigenfalls die erforderlichen baulichen Auflagen.

Planung von Schutzmaßnahmen

Die Naturgefahrenkarte gibt nicht nur Auskunft über den Umfang sowie die Intensität und Eintretenswahrscheinlichkeit eines Ereignisses, sondern sie lässt auch erkennen, ob andere Gefahrenprozesse im gleichen Geländeabschnitt erwartet werden müssen und daraus eine zusätzliche Belastung eines Schutzbauwerkes resultieren kann. Keine Informationen enthält sie bezüglich der Riskosituation, d.h. zur Dringlichkeit von Schutzmaßnahmen als Folge des Verhältnisses von Gefahrenpotenzial zu Schadenpotenzial. Das Gebot der Kosteneffizienz verbauungstechnischer Massnahmen sowie die Bestimmung der Reihenfolge bei der Realisierung von Schutzmassnahmen und deren Begründung sind jedoch beim Vorliegen einer Naturgefahrenkarte von spezieller Wichtigkeit. Als Folgeschritt wurde deshalb eine Methodik der Risikoanalyse erarbeitet, welche derzeit in der Praxis getestet wird.

Schutzwaldpflege

Für das Gebirgsland Liechtenstein ist das Vorhandensein stabiler Schutzwälder von existenzieller Bedeutung. Die seit Jahren tiefen Holzpreise sowie die sich abzeichnende schlechtere finanzielle Ausgangslage der Waldeigentümer zwingen alle Beteiligten zur Prioritätensetzung bei der Waldpflege. Die Schutzwälder sollen daher bezüglich ihrer Wichtigkeit in verschiedene Kategorien unterteilt und die Pflegearbeiten vom Land unterschiedlich stark finanziell unterstützt werden. Diese Ausscheidung der Schutzwaldkategorien stützt sich ganz wesentlich auf die Naturgefahrenkarten ab und wäre ohne diese Grundlage nicht mit der erforderlichen Genauigkeit machbar.

Einsatzplanung in Notstandssituationen
Die umfassende Darstellung der Naturgefahrensituation erleichtert die Organisation von Einsätzen der Sicherheitsdienste im Krisenfalle. Bergungs- und Überwachungseinsätze, Verkehrsregelungen, usw. können vorgängig geprobt werden und sind daher im Schadenfalle kurzfristig möglich.

Information
Raumplanungs- und Verbauungsmaßnahmen sind nur realisierbar, wenn Behörden und Bewohner umfassend über deren Notwendigkeit informiert sind. Durch die Naturgefahrenkarte kann diese Orientierung objektiv erfolgen und damit gleichzeitig ein Beitrag zur Förderung des Risikobewusstseins geleistet werden. Der aktuelle Stand der Gefahrenkarte ist über das Internet einsehbar.

Fazit
Die Vorhersage und Quantifizierung von Naturgefahren-Ereignissen ist aufwändig und nicht immer problemlos möglich. Trotzdem lohnt sich die Erstellung einer Naturgefahrenkarte, denn sie bildet das wohl effizienteste Instrument für einen langfristig sparsamen Mitteleinsatz zur Sicherung von Gefahrengebieten sowie zur Steuerung raumwirksamer Tätigkeiten in gefährdeten Bereichen. Damit können ein Anwachsen des Schadenpotentials begrenzt und zusätzliche Schutzmaßnahmen vermieden werden. ■

Summary
Liechtenstein being a small state with an area of 160 km^2 is situated in the eastern part of the bottom of the slope caused by the Alpine Rhine between 430 und 2,600 metres above the sea level. The Rhine Valley plain being the main settlement area with 33,000 inhabitants, the steep, Rhine Valley-sided slopes as well as the Alpine Space, which is increasingly used as a recreation area, use one third each of the national area. The geological, topographical and climatic situations provide favourable conditions for different harzardous processes taking effect. In the last years, the damage potential of natural hazardous processes has strongly increased due to floodings, rockfall, landslides and avalanches. It is costly to predict and quantify natural hazards and, of course, there are also limitations for precise predictions. But nevertheless, it is very helpful to produce a map of natural hazards as it provides the most efficient instrument to derive specific measures for the protection of hazardous areas in an efficient way in the long term and to steer spatially relevant activities in hazardous areas. This might help to limit the increase of the damage potential and to avoid additional protective measures.

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INTERREG III B Forschungsprojekt im Alpenraum: NAB – Naturpotenziale Alpiner Berggebiete
Natural space analysis for alpine mountain areas

Im Interreg III B Projekt *„Naturpotenziale Alpiner Berggebiete“ (NAB)* sind Experten und Dienststellen aus den Alpenländern Deutschland, Italien, Schweiz, Slowenien und Österreich fachübergreifend beteiligt, um mehr *Sicherheit und Effizienz bei der Naturgefahrenbewertung und -vorhersage* zu bekommen. Die dabei angewandten Standards werden international harmonisiert und abgeglichen. Ein weiterer Schwerpunkt des Projektes NAB ist die Weiterentwicklung einer neuen und zielgerichteten *Schutzwaldstrategie* zur Minimierung des Hochwasser- und Murenrisikos in Wildbacheinzugsgebieten. Abgerundet wird das Vorhaben durch eine Kommunikationsstrategie zur Vermittlung der Ergebnisse an die Verantwortlichen und ein Internet gestütztes Informationssystem für Experten.

Ergebnisse für die Zukunft
Die ausgewerteten Daten und die Verwendung neuer Instrumente liefern wertvolle Grundlagen für die Prävention vor Naturgefahren.

- Verbesserung der fachübergreifenden Zusammenarbeit zur Risikominimierung von Naturgefahren im Alpenraum.
- Optimierung der Naturgefahrenbewertungsverfahren in Einzugsgebieten und Ableitung von Szenarien und Schutzmaßnahmen.
- Standardisiertes Standortmodellierungsverfahren für den Schutzwald und die Entwicklung von Managementplänen für alpine Schutzwälder (Standortkarte inkl. Beschreibung und Waldbauhandbuch).
- Konzeption eines Naturraummanagements (inkl. Managementpläne und Maßnahmenplanung) zur Verbesserung der Analyse und Prävention.
- Aufbau eines Internet gestützten Informationssystems für die beteiligten Dienststellen und Kommunikationsstrategie zur Hebung des Risikobewusstseins.

Results for the future
Data evaluated on a transdisciplinary basis and the use of new tools will provide a valuable foundation for the prevention of natural hazards.

- *Enhanced transdisciplinary collaboration for the reduction of natural hazards in the Alpine Space.*
- *Optimisation of natural hazard evaluation processes in catchments and elaboration of scenarios and protection measures derived from that optimisation.*
- *Standardised site modelling procedure for protection forests, and development of management plans for Alpine protection forests (site map, including site description and silvicultural manual).*
- *Blue-print for natural space management (including management plans and action plans) for enhanced analysis and prevention.*
- *Establishment of a Web-based information system for the authorities involved and of acommunication strategy to improve hazard awareness.*

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Ecological engineering for gully erosion control in France

Ecological engineering could be defined as the use of knowledge of the functioning of ecosystems (ecology) to establish strategies for action on degraded lands (engineering). Therefore ecological engineering for erosion control uses techniques and measures to establish a vegetation cover aiming to protect against erosion. France has a long-standing experience in this field, especially for gully restoration. Investigations are currently carried out to optimise the techniques, which are therefore applied in large areas for gully erosion control.

by Dr. Freddy Rey, Cemagref Grenoble, France

RTM: the oldest Erosion Control Service of the world

Erosion problems appeared in France in the XIXth century due to deforestation and overgrazing (Vallauri, 1998). Land degradation was responsible for floods, debris flows and torrential lava, especially in mountain lands. Laws were therefore established in 1860 to combat erosion and the *'Restauration des Terrains en Montagne (RTM)'* services were created to organise restoration actions. Operations for the ecological restoration of degraded catchments were carried out since 1880. Different techniques were used: civil engineering used in torrents was combined with bioengineering used in small gullies (Poncet, 1995).

Ecological engineering for gully erosion control

Ecological engineering for gully erosion control implicates to determine intervention rules for degraded land restoration. As a first step, civil engineering must be used within torrent beds. Then bioengineering can be used in small gullies (with a surface area less than one hectare). Bioengineering generally corresponds to the use of plants on gully walls and on cuttings in gully floors. Bioengineering methods using cuttings are fascines, wattle fences, brush layers and brush mats (Schiechtl and Stern, 1996). They produce a vegetation cover on soils which avoids erosion and might play a filtering role permitting sediment trapping.

Current situation and investigations in France

Organizations in charge to restore land in mountain areas must establish an optimal management for erosion control, i.e. guarantee sufficient protection against erosion with fewer interventions. Due to budgetary restrictions, an optimal level of erosion control can only be achieved within the given financial resources. Against this background, we try to better understand how vegetation and bioengineering methods can deliver an optimal erosion control. In particular, we think that it is not necessary to establish a total vegetation cover in a catchment to stop the sediment yield owing to the role of vegetation barriers in sediment trapping (Rey and Berger, 2002).

Investigations aim at determining minimally eroded covers to be restored by bioengineering, especially in torrential gullies. Ecological engineering for gully erosion control is an interdisciplinary approach. Therefore, we need to investigate various fields: interactions of vegetation erosion, vegetation dynamics, techniques of bioengineering, methods for the management of protection forests and modelling.

Applications

Results of investigations on the efficiency of vegetation and bioengineering methods for gully erosion control are currently used to rehabilitate eroded land. It is therefore possible to restore eroded gullies after forest fires, rock slides or heavy storms and gales which caused the loss of vegetation covers on erodable soils (see example on the next page). It is also possible to decrease the silting of reservoirs and ponds due to erosion and to an increased sediment yield in rivers. ■

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Cemagref

Cemagref is a French research institute for agricultural and environmental engineering. The Mountain ecosystems and landscapes research unit, located in Grenoble, especially works on interactions between natural hazards (erosion, rockfalls, avalanches…) and vegetation. Investigations on bioengineering and forests for erosion control are carried out in cooperation with universities, French land managers and foreign research institutes, in particular in European projects. For more information please see: www.cemagref.fr

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Ecological rehabilitation for erosion control in the "Grands Goulets" natural site (Vercors, France)

by Dr. Freddy Rey, Cemagref Grenoble, France
Ing. François-Xavier Nicot, Office National des Forêts, France

Introduction
A scenic road for tourists crosses the "Grands Goulets" natural site. Due to heavy rock fall events, the forests and other vegetation have been destroyed upslope of this road, thus paving the way to potential erosion hazards. Soils were still in place and it was necessary to take actions to maintain them and to prevent gully formation. Therefore, it has been decided to rehabilitate these degraded slopes with ecological engineering techniques using vegetation species close to those naturally grown on the site. Soils, climate conditions, potential erosion processes and natural vegetation dynamics were analyzed to provide information for a decision on specific techniques to be applied.

Results and impacts
The pictures illustrate the vegetation growth and the regeneration of cuttings two months after the rehabilitation works. Plants, bushes and grass, have developed thus recreating the vegetation cover. Cuttings also made good progress with root formation and growth of leaves thus guaranteeing the sustainable roughness of the palisades. *Salix purpurea* seemed to develop more and faster than *Salix incana*. So far, no gully formation has occured but more time is needed to assess the success of the operation for preventing erosion. Landscape rehabilitation should certainly be successful, as a "green cover" is rapidly developing and degraded land is restored.


Rehabilitation of degradated slopes in the "Grands Goulets".


Vegetation growth two months after rehabilitation work.

Rehabilitation works
Rehabilitation works for erosion control have been carried out in 2004. As a first step, palisades with 550 meters in lengh have been installed on a total surface area of about 5 ha. Palisades are small barriers made of stakes backed by cuttings which are piled up. They are rough works being 0.50 m high, installed on the slope every 3 to 5 m. They prevent the downside flow of mud and eroded land during heavy rainfall events and they prevent gully formation. Willow *(Salix)* species were used for cuttings, especially *Salix purpurea* and *Salix incana*. Then, the plantation of bushes and trees has been carried out on the palisades and between each of them. Planted species were the same as the natural vegetation observed on the site such as *Buxus sempervirens, Acer campestre* or *Sorbus aria*. Turfing has also been applied out with local species.

Goals and tasks for the future
The success of this rehabilitation project will be evaluated in the longer run to determine the growth of plants and to monitor the erosion processes. The effect of distance between palisades has to be assessed as well to learn more on the optimal distance and thus to reduce the costs of restoration measures. It also has to be analyzed which willow species have more efficient regeneration effects. Specifically, it should be tested if *Salix purpurea* should be preferred to *Salix incana* and it should also be tested, if other species may be used as well. ■

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For more information on this project
Please see the addresses on page 23

La reconquête des pistes de ski par des espèces natives
Soil restoration on ski-runs by native plants

Pour rendre la pratique du ski plus sûre et plus confortable, le relief naturel des versants est souvent totalement remodelé pour créer les pistes de descente et implanter les remontées mécaniques. Ces travaux ont pour conséquence la destruction des biocénoses et des sols en place. S'instaurent alors des processus d'érosion et de déstabilisation des pentes qui conduisent à des modifications paysagères importantes, des problèmes de sécurité, une diminution de qualité des alpages. C'est pourquoi, depuis plusieurs années, on entreprend des opérations de remise en état des sols mettant en œuvre la terre végétale récupérée avant travaux ou des déchets organiques, avant leur repeuplement par voie de semis à partir d'espèces végétales herbacées allochtones. Or, ces communautés végétales changent spontanément dans le temps et, en particulier, s'enrichissent en espèces provenant de populations autochtones situées aux abords des pistes.

par Françoise Dinger, Ingénieur de recherche, Cemagref – Groupement de Grenoble, St-Martin d'Hères (F)

La neige est depuis de nombreuses années le support d'activités touristiques importantes. On peut assimiler la neige à un outil économique qu'il faut préparer, gérer, entretenir et parfois créer, pour permettre le démarrage en toute sécurité des activités sportives le plus tôt possible dans la saison hivernale. Les pistes de ski sont donc des ouvrages construits de toutes pièces; leur remise en état ne s'improvise pas.

Dès 1986 le professeur Alexander Cernusca insistait sur la nécessité de *«faire attention à l'origine de la provenance des semences»* utilisées en végétalisation des pistes de ski en recommandant de respecter *«le bon rapport entre les herbes non graminéennes, les plantes trifoliées et les graminées»*. Le Cemagref avait engagé, pour sa part, des recherches sur le matériel végétal depuis 1978.

Les contraintes naturelles et anthropiques des domaines skiables

Les contraintes fortes sont essentiellement dues aux effets de l'altitude. Ainsi le froid ralentit ou inhibe les fonctions vitales de tous les êtres, les périodes de végétation sont fortement diminuées surtout au-dessus de 2000 m. L'air est moins dense et joue moins son rôle de frein thermique, car il ne s'oppose plus au rayonnement solaire. A tout cela ajoutons l'assèchement des pentes accentué par le vent. Tous ces facteurs liés à l'altitude ont aussi des répercussions sur les sols : l'alternance gel/dégel désagrège les roches, provoque des éboulements et, plus généralement, une forte érosion de surface. De plus, cette couche de matériaux qui sert de support, de réservoir d'eau et de nourriture pour les plantes est peu épaisse en altitude; elle va faire l'objet de bouleversements importants lors de la création des pistes.

La lutte contre l'érosion et la préparation des sols

En fin de chantier, le sol étant totalement décapé, on observe souvent des problèmes liés à l'érosion, et la construction de revers d'eau en travers des pistes est alors indispensable.

Il faut parfois protéger le sol et la mise en place de toile de jute avant le semis créé des conditions microclimatiques favorables à la germination et l'installation d'une végétation dense et homogène, tout en s'opposant sur les pentes au processus d'érosion dû au ruissellement.

Aux basses températures atmosphériques, le bilan thermique d'un sol recouvert par de la toile de jute est supérieur à celui d'un sol nu; des essais ont aussi mis en évidence la capacité de la toile de jute à absorber jusqu'à cinq fois son poids en eau; en la restituant peu à peu, la toile participe à l'alimentation de la plante. Enfin, la toile imbibée intercepte une bonne partie de l'énergie solaire utilisée à l'évaporation de son eau. Ainsi l'été, le sol reçoit moins de chaleur et l'eau qu'il contient s'évapore moins vite que celle du sol nu.

La reconstitution du substrat

La solution idéale est sans conteste de réutiliser la terre végétale existante si on a pris soin de la récupérer dans d'excellentes conditions, avant le démarrage du chantier. A défaut de terre végétale, on peut utiliser des amendements qui constituent un réservoir d'eau et d'aliments.

Des essais ont été mis en place en 1987, sur une zone dégradée à 2245 m d'altitude, dans la station de ski de La Plagne. Pour être efficace en reconstitution de substrat, le compost de boues devait être utilisé à raison de 150 T/ha, c'est-à-dire en couche de 3 à 5 cm d'épaisseur.

D'année en année, on a constaté que la couverture végétale se densifiait, que les espèces se reproduisaient et assuraient la pérennité de la couverture protectrice du sol. On a constaté également sur les parcelles le retour des plantes natives.

Le matériel végétal

Les espèces végétales utilisées sur les pistes de ski sont uniquement des herbacées car la couverture végétale souhaitée est un tapis ras, dru, capable de retenir la neige et permettre la pratique du ski par faible enneigement. Les espèces choisies doivent s'installer rapidement pour s'opposer aux processus d'érosion tout en cédant la place progressivement aux populations autochtones qui sont les seules à garantir l'intégration écologique et paysagère des sites aménagés. Dans ce contexte, les graminées et

Projection de compost sur piste de ski.
Photo: Françoise Dinger, Cemagref

légumineuses du commerce ne constituent pas forcément le matériel végétal le mieux adapté. En effet si nous connaissons bien leur comportement en plaine et en semis pur, des recherches n'ont pas véritablement été engagées pour faire progresser la connaissance de leur comportement en altitude et en association. A partir de 1980, une trentaine d'espèces et variétés du commerce ont été testées dans différentes stations de ski puis des recherches sur les plantes pionnières ont été engagées; celles-ci étant parfaitement adaptées aux conditions extrêmes ce sont ces populations qu'il convient d'introduire dans les mélanges à utiliser en altitude. Toutefois, aujourd'hui, elles ne constituent qu'un complément aux espèces du commerce traditionnellement utilisées. Au fil des années nous avons aussi constaté le retour des espèces présentes à proximité des chantiers et qui accroissent avec le temps la biodiversité et la pérennité de la couverture végétale.

Les recherches conduites sur le domaine skiable de La Plagne

L'analyse des données de terrain receuillies à partir de 1997, a démontré un enrichissement des communautés végétales en fonction de leur âge: de 1 à 4 ans les espèces semées dominent, de 4 à 15 ans les plantes natives arrivent progressivement en fonction de la qualité du substrat, de 15 à plus de 30 ans les espèces semées disparaissent et la recolonisation par les plantes natives s'accélère. Ainsi, après une trentaine d'années, on retrouve sur certaines pistes de ski l'écosystème qui avait été détruit au moment de la création de la piste par les travaux de terrassement. Cette reconstitution s'accompagne même d'un retour à une plus grande diversité biologique. Elle permet donc de réussir dans l'essentiel des cas une véritable réhabilitation de ces espaces aménagés. L'ensemble de ces observations a permis de faire évoluer les mélanges utilisés en altitude; les quelques graminées utilisées dans les années 70 ont été progressivement accompagnées par des légumineuses puis des plantes sauvages.

La gestion des espaces réhabilités

Lorsque l'on considère que la végétation est bien installée, on peut l'ouvrir au pâturage qui est, en altitude, un excellent moyen pour entretenir les pistes de ski. On obtiendra ainsi à la fin de l'automne le *«tapis brosse»* souhaité prêt à recevoir les premiers flocons, qu'ils soient naturels ou de culture.

Conclusion

La connaissance parfaite du fonctionnement des écosystèmes avant perturbation est essentielle pour réussir la réhabilitation écologique des espaces aménagés. Elle conditionne le bon choix des semences, des techniques et des produits qui vont permettre une remise en état durable des sites et un retour progressif à l'écosystème d'origine. Il est indispensable, d'appliquer une démarche cohérente en mettant en place les différentes étapes de la réhabilitation. Cette démarche doit être parfaitement adaptée à chaque cas et les recherches engagées, qui se poursuivent encore aujourd'hui, ont permis de faire évoluer les pratiques en tenant compte des succès et échecs des différents essais. Les techniques de réhabilitation permettent de concilier enjeux économiques et environnementaux des ouvrages, de les intégrer au paysage tout en assurant une protection rapide des activités concernées. ■

Summary

The natural relief of the slopes is often completely reorganized to create safer and more confortable ski-runs and to establish ski lifts. These works result in the destruction of soils and biocenoses. As a consequence, processes of erosion and destabilization of slopes result into significant landscape modifications, safety problems and the reduction of the mountain pastures quality. Therefore, soil restoration is starting with the initial topsoil or organic waste, before revegetation by the way of sowing with immigrant herbaceous species. However, those plant communities do change spontaneously in time and, in particular, the number of species increases with colonization by autochtonous species located near ski-runs.

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Sicherung des Südtiroler Lebensraums vor Erosion, Vermurungen, Wildbächen und Lawinen

Die Sicherung des Lebensraumes vor Naturgefahren und Umweltschäden gehört zu den institutionellen Aufgaben der Landesumweltagentur und der Landesabteilung für Wasserschutzbauten. Übergreifend sind verschiedene Dienste der Landesverwaltung, etwa aus den Bereichen Lawinenschutz, Forst, Landwirtschaft, Tiefbau, Raumplanung, Ingenieurbiologie, usw. beteiligt. Getroffen werden aufgrund von Schadenereignissen und anhand von Naturgefahrenkarten bauliche sowie ingenieurbiologische Schutzmaßnahmen zur Eindämmung von Schäden durch Erosion, Überschwemmungen, Vermurungen und Lawinen.

von Dr. Rudolf Pollinger, Direktor der Landesabteilung für Wasserschutzbauten, Autonome Provinz Bozen-Südtirol, Bozen (I)

Der Schutz beginnt oberhalb der Waldgrenze
Der ingenieurbiologische Dienst befasst sich in seinen Arbeitsschwerpunkten mit Hangsicherungsmaßnahmen, Sicherungs- sowie Revitalisierungsarbeiten an Gewässern und im weiteren Sinne mit dem *Erosionsschutz oberhalb der Waldgrenze*. Dabei bedient man sich der biotechnischen Eigenschaften der Pflanzen. Optimal eingesetzt, sind sie ein wirkungsvolles Mittel zur Erosionseinschränkung und zur Sicherung von Böschungen. Auch dienen sie zur Rückführung von naturnahen Vegetationsformen und zur Verbreitung artenreicher Flora.

Die ingenieurbiologischen Arbeiten sind hinsichtlich den klimatischen, topographischen und morphologischen Verhältnissen Standortverhältnissen angepasst. Vergleicht man die Arbeitsschwerpunkte auf dem Gebiet der Ingenieurbiologie in der Vergangenheit (vor ca. 10-15 Jahren) mit denen von heute, so stellt man eine Verlagerung der Arbeiten zu Gunsten von Hangsicherungsarbeiten fest, während früher vermehrt Begrünungsarbeiten oberhalb der Waldgrenze durchgeführt wurden.

Erosionsschutz durch Begrünung in Hochlagen
Die *Begrünungsarbeiten im Hochgebirge* bewirkt die Schaffung eines Narbenschlusses, um die Erosion einzuschränken. Begrünungen größerer Ausdehnung wurden schwerpunktmäßig vor allem im Erosionsgebiet Meran 2000 (Gemeinde Hafling), im Alpbach in Plawenn, im Erosionsgebiet Gampertal (Gemeinde Schlanders), im Gebiet Pfannhorn in Toblach, Ruedlgraben Welsberg durchgeführt. Zu erwähnen sind außerdem die Begrünungsarbeiten von Anbrüchen in Pens, Lüsen, Gadertal und in vielen andern Gemeinden Südtirols.
Die Pflegearbeit zur Etablierung von älteren Begrünungsbeständen sowie die Begrünung neuer Erosionsflächen erfolgen vorwiegend in den Sommermonaten. Durch die intensive Forschungsarbeit im Hinblick auf die Produktion standortangepasster Saatgutmischungen ist man heute in der Lage, über geeignetes Saatgut für Hochlagen zu verfügen, welches über 60% *autochthone Arten* aufweist. Ältere Begrünungen, welche in ihrer Zusammensetzung den Bedingungen der Hochlagen nicht entsprechen, werden durch die Einsaat alpiner Gräser und Kräuter verbessert, um auf diese Weise die natürliche Einwanderung zu unterstützen. Eine organische Düngergabe begünstigt die Pflegearbeiten und trägt mit einer befristeten Weidebeschränkung wesentlich zum Gelingen der Erosionsschutzmaßnahmen in den obersten Einzugsgebieten bei. Dort, wo die Begrünung bereits gesichert und das Wachstum von alpinen Nadelholzarten noch möglich ist, werden zusätzlich Gehölze gepflanzt.


Erosionsgebiet Meran 2000. Photo: R. Pollinger

Schutzverbauungen gegen Lawinen und Murgängen
Bei *Lawinenverbauungen* werden aufgrund der Gefahrenlage und der Voraussetzungen im Gelände verschiedene Verbauungsformen eingesetzt, wie Schneebrücken, Schneenetze, Schneeschirme, u.dgl. Solche Schutzanlagen wurden flächendeckend oberhalb vieler Ortschaften vor allem im Bereich des Alpenhauptkammes errichtet. Hohe Anforderungen werden auch an Verbauungsmaßnahmen bei der *Ereignis- und Risikobewältigung von Murgängen* gestellt. Entsprechende Verbauungs- und Sanierungsarbeiten werden seit vielen Jahrzehnten im gesamten Landesgebiet durchgeführt und umfassen tausende von Schutzbauten.

Maßnahmen an Gewässern

Die *Wildbachverbauung* umfasst integrale ingenieurbiologische und technische Maßnahmen zur Beruhigung von Wildbächen und zur Sanierung von Geschiebeherden und Rutschhängen an Bächen. Leitbild heute sind naturnahe Wildbäche, die eine natürliche Dynamik zulassen. Typische technische Bauwerke sind Wildbachsperren, welche dazu dienen, hohes Gefälle zu brechen, die Sohle zu erhöhen, um die Talflanken zu konsolidieren, mitgeführte Feststoffe aufzufangen und natürlich transportiertes Geschiebe zu dosieren.

Ingenieurbiologische Maßnahmen an Gewässern umfassen sowohl Gestaltungs- als auch Bepflanzungsarbeiten. Das gemeinsame Ziel ist der Schutz vor Naturgefahren und zugleich die ökologische Aufwertung der Gewässer durch die Überführung eines naturfremden Zustandes in einen naturnäheren Zustand. Dies kann beispielsweise durch die Verwendung standortsangepasster Weiden und bewurzelter Gehölze oder durch die Umgestaltung und den Rückbau des Gewässerbettes bewirkt werden.

Ein wesentlicher Aufgabenschwerpunkt ist die Pflege der Ufervegetation, welche unkontrolliert maßgeblich zum hydraulischen Stolperstein werden kann. Die Vegetation – vor allem wenn sie stufig aufgebaut und einen vitalen Nebenbestand aufweist – kann den hydraulischen Querschnitt entscheidend verringern und kann somit Ursache für das Ausufern des Gewässers sein. Bei solchen Pflegeeingriffen müssen ökologische Erfordernisse, wie etwa die Hauptbrutzeiten und die Saftruhe, berücksichtigt werden. Deshalb wird die Uferpflege vorwiegend außerhalb der Vegetationszeit besorgt. Solche Maßnahmen an Gewässern wurden in den letzten Jahren u.a. an der Rienz (Gemeinde Vintl), an der Talfer in Bozen, an der Etsch (Gemeinden Mals und Glurns), am Rambach (Gemeinde Mals), am Schland-raunbach (Gemeinde Schlanders) sowie am Sinichbach (Gemeinde Hafling) getroffen.

Oft sind bauliche und ingenieurbiologische Schutzmaßnahmen unumgänglich, um größere Schäden zu verhindern. Photo: Ilsn

Forschungs- und Öffentlichkeitsarbeit

Die ingenieurbiologischen Arbeiten werden oft durch Forschungsarbeiten wissenschaftlich begleitet und durch *Öffentlichkeitsarbeit* zur Information und Bewusstseinsförderung in der Bevölkerung ergänzt. In den vergangenen Jahren wurden regelmäßig öffentliche Führungen auf Baustellen des Sonderbetriebes für Bodenschutz, zu Wildbach- und Lawinenverbauungen, Hangsicherungen und Begrünungen durchgeführt und Vorträge zu verschiedenen Themen der Ingenieurbiologie gehalten.

Die *Forschungsvorhaben* befassen sich inhaltlich mit der Verbesserung von Saatgutmischungen hinsichtlich der Standortstauglichkeit sowie mit der Quantifizierung der Einsatzmöglichkeiten alpiner Gräser und Kräuter.

Gemeinsam mit der Universität für Bodenkultur in Wien wurden Diplomarbeiten zu Themen der Begrünung in Hochlagen auf dem Pfannhorn (Gemeinde Toblach) sowie auf Meran 2000 (Gemeinde Hafling) betreut.

Durch den Übergang der Etsch in die Verwaltungshoheit des Landes war es zunächst notwendig, eine Bestandeserhebung der Vegetation entlang der Etsch durchzuführen, welche die Grundlage für die Erstellung eines Pflegeplanes darstellte. Dieser Pflegeplan führt die notwendigen Pflege- und Wiederherstellungsmaßnahmen auf, die derzeit umgesetzt werden. Auch wurde in Südtirol erstmals auf einem Teilstück der Ahr zwischen Mühlen und Bruneck ein sogenanntes Gewässerbetreuungsprojekt als Pilotprojekt erstellt. Dieses Vorhaben wird in einem Mehrjahresprogramm umgesetzt und stellt eine Möglichkeit dar, schutzwassertechnischen sowie ökologischen Anforderungen gleichermaßen gerecht zu werden. ■

Summary

Reducing the risks of natural hazards and environmental damages is an essential part of the overall tasks of the “Landesumweltagentur” (provincial environmental agency) and of the “Landesabteilung für Wasserschutzbauten” (provincial department responsible for water protection building). Various provincial administrative services are involved like protection against avalanches, forestry, agriculture, underground work, spatial planning, bioengineering, etc. Derived from actual incidents and maps of natural hazards, protective measures are undertaken in construction and bioengineering to reduce damages caused by erosion, floods, debris flow deposition and avalanches. This article illustrates some practical activities in erosion control above the forest line by slope stabilisation and by greening, near-natural torrent control and embankment etc, which have been implemented in the municipalities of the Province of Bolzano-South Tyrol.

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Soil erosion and land use changes in the Dragonja River basin, Slovenia

In many parts of Slovenia, severe soil erosion in the middle of the 20th century slowed down until the end of the century. This happened due to rapid land use changes and the following natural forest succession. In the Soca River basin, goat grazing was forbidden in order to stimulate natural reforestation of the area and to prevent infrastructure and settlements from avalanches. The karstic areas in Slovenia near the Adriatic Sea coast were naturally reforested, stimulated by migration from agricultural land to urban centers. The Dragonja River basin is a good example of such a development.

by Prof. Matjaz Mikos, Faculty of Civil and Geodetic Engineering, University of Ljubljana & Dr. Lidija Globevnik, Senior Researcher, Institute for Water of the Republic of Slovenia, Ljubljana (SI)

Introduction

The Dragonja River catchment (98 km^2) in South-West Slovenia is a good example of changes in a Mediterranean river's hydrological and morphological regime imposed by rapid land use changes. The geological substratum consists of flysch and prior to 1970 the land was cultivated and intensively used. Therefore, considerable soil erosion processes developed in the basin. In the last 30 years, anti-erosion measures coupled with natural succession on the abandoned agricultural land have led to a considerable increase of the vegetation cover. As a consequence of such a development not only soil erosion and runoff decreased in the basin but also the river became less active.

Field analyses

The aerial photographs taken in the last three decades were interpreted and have shown a large land use change: the forest cover increased from 22 % in 1971 to 62 % in 1995. Furthermore, less than 20 % of the former erosion ditches are still intensively eroded today and only some of the cliffs are active sediment sources. Monitoring data in this period showed negative trends both concerning the measured annual rainfall amounts as well as rainfall erosivity using measured 5-minute intensities. These land use changes have influenced the hydrological cycle and a reduction of discharge duration curves of the Dragonja River was observed. For the same period of interest, an analysis of sediment production and supply to the river network was performed using the original Gavrilovic equation. The yearly sediment yield changed and was in 1995 estimated at only 40 % of the quantities from 1971. Furthermore, an analysis of the sediment transport capacity of the Dragonja River was performed, using simulated discharge duration curves obtained from a trend analysis for the period 1961–1995 and the Meyer-Peter & Müller transport equation (1948). The sediment transport capacity for bed load was estimated to be reduced due to a decreased number of active floods per year and due to decreased discharge duration curves. The reduced sediment supply and sediment transport capacity has caused morphological changes in the alluvial riverbed.

As the sediment inflow from tributaries was reduced, a comparison of measured river cross sections in 1977 and from the period 1996-2000 showed that the Dragonja River pushed to an explicit latent erosion state with only occasional sediment transport events and a clear incision trend. Only at local widenings of the river it came to local sedimentation areas. Today, the Dragonja River is a typical gravelbed river with local riverbank undercutting. An analysis of aerial photographs showed that the active riverbed width is locally reduced to one half of its original width. Some wider parts of the riverbed and riverbanks are now fully overgrown.

Soil erosion vs. other denudation processes

Slovenia has nowadays a forest cover on more than 60% of its area and is the third richest country with forests in Europe. This fact explains why in Slovenia soil erosion has steadily been decreasing and is nowadays a less important denudation factor as it used to be some decades ago. Different mass wasting phenomena, i.e. land sliding (especially numerous earth slides and slumps) and to a smaller extent also rock falling, are releasing more and more sediments. Fluvial erosion processes are very active in more than 25,000 km of torrential and river channels. ■

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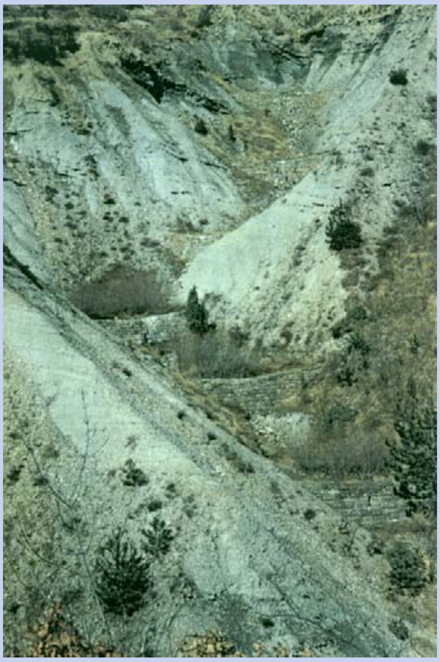
Anti-erosion measures in the Dragonja River headwaters

by Dr. Lidija Globevnik, Institute for Water of the Republic of Slovenia, Ljubljana

Problem / Introduction

The Dragonja River basin (98 km^2) is a typical sub-Mediterranean area in the littoral part of Slovenia (in its SW). In the early 1960s, forests covered 26 % and grasslands 39 % of the entire basin. Due to the facts that the geological substratum consists of flysch and that the land was agriculturally intensively used, until the late 1960s considerable erosion processes developed. They were not restricted to agricultural land only. Even though the average annual precipitation in the area is about 1000 mm, the rainfall is an important erosion factor under sparse or no vegetation (e.g. RUSLE rainfall and runoff erosivity factor R in the area is about 3000 MJ ha^{-1} mm h^{-1}).

- The forest cover percentage changed from 22 % in 1971 to 62 % in 1995, the major change happened in the eastern part of the basin: from 25 % to 75 %.
- The yearly sediment yield changed and in 1995 it was estimated at only 40 % of the quantities from 1971.
- Due to a lower river erosion activity, vegetation overgrew much of the river banks.
- Natural forest succession on abandoned agricultural land was the most obvious consequence of human land use changes.



1. Photo: Eroded slopes and check dams in the Dragonja River headwaters in 1970.

2. Photo: The same slopes after 25 years in 1995. Both pictures: Institute of Water.

Objectives

In 1970s, wide spread classical torrent control works were planned and carried out mainly in headwaters in order to slow down water and soil erosion, and especially to protect agricultural land. Meanwhile, land use changes happened within a few decades due to political and social changes in the basin. Mainly due to the fast urbanisation vast parts of agricultural land were abandoned. In the late 1990s, the basin was selected as a hydrologically instrumented basin. After this was realised step by step and a combined cabinet and field study was done in order to identify long-term changes in the hydrological and morphological regime in such a typical sub-Mediterranean area subjected to rapid land use changes.

Results and impacts

- Stabilizations of torrential channels by check dams have been carried out together with vegetation stabilisation works in eroded areas, particularly afforestation with Black Pine.
- Today, less than 20 % of the former erosion ditches are still intensively eroded, and only some of the cliffs are active sediment sources.

Goals and tasks for future

The environmental impacts of large human interventions on catchment hydrology and river morphology are well known, whereas the impacts of less visible, dispersed and lasting changes, such as afforestation, natural forest succession and anti-erosion measures, are much more difficult to assess. In the experimental basin of the Dragonja River further field investigations have been and will be performed in order to gain an even better insight into the single components of the hydrological and sedimentological cycle. One such open question to be answered is e.g.: To which extent may natural forest succession be tolerated as a successful anti-erosion factor in the sub-Mediterranean climate, where water abundance in summer is and will be an even more limiting factor of development? ■

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Erosionsschutzmaßnahmen im österreichischen Programm für eine umweltgerechte Landwirtschaft

Im österreichischen Programm zur Förderung einer umweltgerechten, extensiven und den natürlichen Lebensraum schützenden Landwirtschaft (ÖPUL 2000) werden eine Reihe von Maßnahmen angeboten, die das Erosionsrisiko auf landwirtschaftlich genutzten Flächen reduzieren sollen. Diese Maßnahmen werden im Folgenden vorgestellt und ihre Wirksamkeit und das derzeitige Ausmaß ihrer Anwendung besprochen.

von Peter Strauss, Institut für Kulturtechnik und Bodenwasserhaushalt, Bundesamt für Wasserwirtschaft, Petzenkirchen & Sigbert Huber, Umweltbundesamt, Wien (A)

Mit dem Beitritt Österreichs zur Europäischen Union im Jahr 1995 wurde das österreichische *Programm zur Förderung einer umweltgerechten, extensiven und den natürlichen Lebensraum schützenden Landwirtschaft (ÖPUL)* initiiert, das in seiner aktuellen Form als ÖPUL 2000 (BMLFUW, 2000) vorliegt. Ziel dieses Programmes ist unter anderem, zur Einführung oder Beibehaltung umweltschonender landwirtschaftlicher Produktionsverfahren, zur Erhaltung der Landschaft und zum Schutz unserer natürlichen Ressourcen beizutragen. Um dieses Ziel zu erreichen wird eine Vielzahl verschiedener Maßnahmen angeboten, an denen die Landwirte teilnehmen können. Die finanzielle Unterstützung hängt dabei von der Art der durchgeführten Maßnahmen ab. Direkt unter dem Titel Erosionsschutz werden folgende Maßnahmen angeboten:

- *Erosionsschutz im Ackerbau:*
  Gefördert wird der Anbau in Mulch- oder Direktsaat.
- *Erosionsschutz im Weinbau:*
  Gefördert wird eine flächendeckende Bodenbedeckung durch Grasmulch, Aussaat einer Begrünung, Abdeckung durch Stroh, Rindenmulch oder Heu in der Zeit vom 1.11.-30.4. oder Bewirtschaftung von Terrassenlagen.
- *Erosionsschutz im Obstbau:*
  Gefördert wird eine flächendeckende Bodenbedeckung durch Grasmulch, Aussaat einer Begrünung, Abdekkung durch Stroh, Rindenmulch oder Heu während mindestens 10 Monaten oder Bewirtschaftung von Terrassenlagen.

Alle diese Maßnahmen gehen von der Idee eines *Erosionsschutzes durch verbesserte Bodenbedeckung* direkt am Schlag aus. Generell ist die Schutzwirkung von Maßnahmen, die den Grad der Bodenbedeckung erhöhen, als sehr hoch einzustufen. Ergebnisse verschiedener diesbezüglicher Untersuchungen weisen zwar starke Unterschiede auf, im großen Durchschnitt kann aber mit einer Reduktion des Bodenabtrags in einer Größenordnung von mehr als 70 % der ursprünglichen Erosion gerechnet werden (STRAUSS et al., 2004).

Daneben gibt es auch eine Reihe von Maßnahmen im ÖPUL 2000, die zwar nicht direkt als Erosionsschutzmaßnahme ausgewiesen sind, bei deren Anwendung aber positive Effekte zur *Verringerung des Bodenabtrags* entstehen. Hierzu gehören z. B. die Verringerung von maisbetonten Fruchtfolgen bei der Förderung biologischer Bewirtschaftung, eine Reduktion von Wintererosion durch Bodenbedeckung während des Winters oder die Verringerung der Fließlängen von Oberflächenabfluss durch Erhaltung kleinräumiger landwirtschaftlicher Strukturen und Neuanlage von Landschaftselementen.

Die Teilnahme von Landwirten an den direkten Maßnahmen zum Erosionsschutz stieg seit Einführung des Programmes kontinuierlich. Im Jahr 2002 wurde eine Gesamtfläche von ca. 150.000 ha gefördert, das entspricht ungefähr 34 % jener Fläche, die durch den Anbau erosionsanfälliger Kulturen (Mais, Rübe, Kartoffel, Sonnenblume, Dauerkulturen) als gefährdet anzusehen ist (Flächenanteile laut Österreichischer Agrarstrukturerhebung 1999). Bei Teilnahme an der Maßnahme „*Erosionsschutz im Ackerbau*“ wird eine Prämie in der Höhe von 44 EUR/ha geleistet. Für die Teilnahme an der Maßnahme „*Erosionsschutz im Obstbau*“ ist eine Prämie von 145 EUR/ha bzw. 291 EUR/ha (abhängig von der Hangneigung der Fläche) vorgesehen und für die Maßnahme „*Erosionsschutz im Weinbau*“ werden zwischen 145 EUR/ha und 799 EUR/ha (wiederum in Abhängigkeit der Hangneigung) Prämie bezahlt. ■

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Effectiveness of erosion control measures in the Austrian Environmental Programme for Agriculture ÖPUL 2000

by Sigbert Huber, Umweltbundesamt (Federal Environment Agency), Austria
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Introduction
The Austrian Environmental Programme for Agriculture ÖPUL 2000 is the main means of supporting agricultural measures to protect the environment. This programme contains specific measures to reduce soil erosion. These measures include a minimum tillage for arable land and the establishment of different percentages of green cover in vineyards and orchards. Other measures like cover crops for arable land in autumn and winter contribute to minimising the erosion risk.

	Average soil loss on arable land					
	Traun-Enns-Platte		Oststeirisches Hügelland		Thermenlinie	
No erosion control (scenario 1)	6.5	100 %	6.3	100 %	4.2	100 %
Situation 2002 (scenario 2)	5.0	77 %	4.1	65 %	4.2	100 %
Optimal erosion control (scenario 3)	1.8	28 %	0.7	11 %	1.4	33 %

Average soil loss on arable land per test area in t/ha/a and %

Objectives
The objective of this research project funded by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management was to investigate the effect and efficiency of these soil erosion control measures. The situation of soil erosion due to water in three selected agricultural areas with different dominating land uses was to be described. The results should contribute to the mid-term evaluation of the EC programme on the development of rural areas.

Methods
In order to evaluate the effectiveness of these protection measures to combat soil erosion, a comprehensive literature evaluation was carried out. For the modelling exercise three test regions with different dominating land uses (Traun-Enns-Platte - arable land, Oststeirisches Hügelland - orchards, Thermenlinie - vineyards) were selected. Within each of these regions a representative catchment area (approx. 6-18 km^2) was selected. Soil erosion was calculated for three scenarios:
1) conventional land management (no erosion control);
2) application of erosion control in 2002; and
3) optimal erosion control (all plots receive erosion control measures).

Results and impacts
For conventional land management *(scenario 1)*, average soil erosion rates of arable land of 6.5 t/ha/a (Traun-Enns-Platte), 6.3 t/ha/a (Oststeirisches Hügelland) and 4.2 t/ha/a (Thermenlinie) were calculated; in orchards, a rate of 3.2 t/ha/a; in vineyards, erosion rates of 8.0 to 9.5 t/ha/a. In 2002 *(scenario 2)*, measures against soil erosion of ÖPUL 2000 were applied on average on 37 %, 26 % and 0 % of the arable plots in the catchments Traun-Enns, Oststeirisches Hügelland and Thermenlinie. This application led to a reduction of soil erosion on arable land of 23 %, 35 % and 0 % compared to rates of scenario 1. Vineyards in the catchment Thermenlinie were treated with erosion control measures by 32 % causing a reduction of erosion of 20 %. Orchards were treated with erosion control measures by 85 % in the catchment Oststeirisches Hügelland causing an average erosion reduction of 47 % compared to scenario 1.

For the estimation of the achievable reduction of soil erosion an optimal application of erosion control measures was presumed for modelling *(scenario 3)*. The result would be a calculated reduction down to 28 % (Traun-Enns-Platte), 11 % (Oststeirisches Hügelland) and 33 % (Thermenlinie) of the values for scenario 1. Moreover, for vineyards and orchards the maximal application would result in an average reduction down to only a few %-points of scenario 1 rates.
Considering the effect of the erosion control measures, an enhanced application of these erosion control measures is recommended, in particular on plots with high erosion risk. It has to be stated that for specific land uses and regions the application of erosion control measures and therefore the reduction of soil erosion can be significantly increased.

Goals and tasks for the future
For further steps in the evaluation process, this exercise could be applied at the national level, but with some adaptions taking into account the necessity to operate on a level of higher aggregated data. The results of this project can be used to adapt the concept of the next stage of the Austrian Environmental Programme for Agriculture. ■

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Vorsorgender Erosionsschutz im Ackerbau –
Förderung des Bodenlebens durch Fruchtfolge, organische Düngung und angepasste Bodenbearbeitungstechnik

Aufgrund von Humusmangel und geringer biologischer Aktivität können sich unsere landwirtschaftlich intensiv genutzten Böden von der fortschreitenden Verdichtung nicht mehr selbst erholen. Dies führt zu verminderter Wasseraufnahme-, Speicher- und Filterfähigkeit der Böden, d.h. zu Überschwemmung, Erosion und sinkender Trinkwasserneubildung und -qualität. Diesem Prozess begegnen, heißt aktiv Maßnahmen zur Förderung des Bodenlebens und der Bodenstruktur anwenden. Mit einer geringeren Intensität der Bodenbearbeitung allein ist es nicht getan.

von Dr. Andrea Beste, Büro für Bodenschutz und Ökologische Agrarkultur: Analyse, Beratung, Fortbildung, Mainz (D)

Das Niederschlagswasser findet nicht mehr den Weg durch unsere Böden

Die Ursachen von Hochwasser und Erosion hängen eng zusammen. Nicht begrünte Äcker, erntefreundliche Pflanzabstände, die Ausräumung der Landschaft, Pflügen quer zum Hang usw. führen direkt zu verstärkter Erosion. Ein Zusammenhang, der wesentlich zur Verdichtung und steigenden Erosionsanfälligkeit unserer Böden führt, wird aber bisher wenig beachtet: *Der Rückgang des Humusgehaltes und der biologischen Aktivität der Böden*. Aufgrund des Fehlens von organischem Dünger mit strukturstabilisierenden Eigenschaften (Mist oder Kompost, nicht Gülle) vereinfachten Fruchtfolgen und fehlender Vegetation über größere Zeiträume, entsteht ein Mangel an organischem Material im Boden und die biologische Vielfalt und Aktivität der Bodenorganismen geht zurück. Dies ist der Hauptgrund für die mangelnde Fähigkeit der Böden, nach der mechanischen Lockerung ein ausgeglichenes Porensystem und eine stabile Bodenstruktur bilden und aufrecht erhalten zu können. Das gilt besonders für Sandböden mit ihren geringen Aggregataufbau-Mechanismen. Das Befahren mit bodenverdichtenden Ackergeräten zerstört ebenfalls die Lebensbedingungen für Bodenorganismen.

Organisches Material für lebendige Böden

Die Stoffwechselprozesse der Bodenbiologie, bestehend aus Pilzen, Algen, Bakterien und Bodentieren, sind maßgeblich darauf ausgelegt, organisches Material abzubauen. Fehlt organisches Material, können viele Stoffwechselprozesse nicht stattfinden und die dafür „zuständigen" biologischen Lebensgemeinschaften sterben teilweise oder ganz ab. So wird die natürliche Bodenfruchtbarkeit verringert und muss künstlich ausgeglichen werden. Der Energieaufwand zur Lockerung der verdichteten Böden und der Bedarf an mineralischen Düngemitteln steigen. Verdichtete Böden können weniger Wasser aufnehmen, speichern und filtern und sind an der Oberfläche äußerst anfällig für Splash (Wassertropfenerosion), wobei weitere Poren verstopfen. Dies führt zu Versiegelung und beschleunigt den Oberflächenabfluss des Wassers. Hinzu kommt der geringe Bewuchs weit stehender Reihen oder offener, nicht begrünter Äcker oder Weinberge. Hieran ändert auch die konservierende Bodenbearbeitung oder die herbizid-intensive Direktsaat wenig.

Vielfalt an Maßnahmen birgt ökologische Vorteile

Vom Standpunkt des Erosionsschutzes ist es natürlich günstig, durch Mulchsaatverfahren Bodenbedeckung zu erzielen. Allerdings kann dies unter saattechnischen und phytosanitären Gesichtspunkten oft nachteilig sein (Herbizideinsatz). Anstatt verdichtete Böden durch Nicht-Bearbeitung einfach ihrem (verdichteten) Schicksal zu überlassen, ist eine aktive Unterstützung des Bodenstrukturaufbaus zu betreiben: Mit Hilfe von *Zwischenfruchtbau* (Bodenbedeckung), mit intensiver *Durchwurzelung* (Lockerung plus Stabilisierung), mit traditioneller *Fruchtfolgetechnik* (Humusbalance), mit *organischer Düngung* (Mist oder Kompost) und *schonender Bodenbearbeitung*, die nicht zwingend nicht-wendend sein muss. Die herbizidfreie Beikrautregulierung des Pfluges hat durchaus einen nicht zu vernachlässigenden ökologischen Vorteil. Im ökologischen Landbau wird die Bodenpflege durch die oben genannten Maßnahmen aktiv betrieben. Eine derart geförderte Bodenstruktur verträgt durchaus zeitweiliges Pflügen in Form einer Sommerfurche, wonach die gelockerte Struktur mit einer Zwischenfrucht biologisch verbaut werden kann. Hierdurch entsteht ein biologisch stabilisiertes, poröses Schwammgefüge mit guten Speicher- und Filtereigenschaften. Durch konservierende Bodenbearbeitung allein ist dies nicht zu erreichen. ■

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Extended Spade Diagnosis for a complex evaluation of soil conditions

by Dr. Andrea Beste
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Problem
Flood, a decreasing quality of groundwater and drinking water and soil loss caused by erosion are under debate. These problems are closely related to soil health as a basic issue. Soil science and agricultural soil management have primarily focused on the production function of soil and in doing so have been successful in increasing the output of biomass in the decades of the rise of modern agriculture. As a consequence the humus content and the activity of soil biota were reduced at the same time. This is at the core of an imbalance of the basic soil functions and results in a tendency to soil compaction and erosion in industrialized agriculture. In contrast, agricultural land use management systems should maintain or restore the balance between all major ecological functions of soils in the long term (habitat function, production function as well as regulation function). According to that, the basic objective is a *high rate of activity of soil life* and a *good soil structure.*

The result of such a diagnosis can be actually derived and applied on the ground. It is an advantage to have an overall, "holistic" result which may not be based on isolated samples and data from laboratory tests. Further improvements of the method were presented in a study with some modifications and supplements (BESTE 2003). This *"Extended Spade Diagnosis" (ESD)* has some advantages:

- The ESD allows to document the ecological effects of different management systems on the soil vitality without an expensive high-tech equipment.
- The ESD combines exact and quantitative data information on soil parameters with the qualitative evaluation of soils in the field.
- Information and results are helpful for agricultural advisers in demonstrating soil quality to farmers because they are close to the experiences of farmers with soil. Therefore, communication between scientific expertise and agricultural work is facilitated.

Left: Crumbly, loose and porous soil. Regular intercropping and organic manuring.
Right: Heavily compacted soil. Maize cropping without intercrops. Both soils: Sandy loam. 2004, Germany. Photos: A. Beste

Objectives
A sustainable management system should protect and stimulate the capability of the soil structure to maintain stability under a broad range of agricultural practices. Water erosion should be minimized. Water cycles, the activity of soil life, the transformation capacity and the tendency to erode are closely linked with the quality of the soil structure.

Complex evaluation of soil conditions
GÖRBING developed a method in the early 1930ies to analyze the relevant aspects in the field labeled *"Spade diagnosis"*. With this method, the soil structure, size, shape and arrangement of soil particles and aggregates as well as the density, root growth and soil moisture may be easily examined. The overall result of this method is helpful to judge the quality of the management practice of farmers and its effects on the major aspects of our objectives in previous years. Crop rotations, tillage systems and alike are relevant factors determining the result of a spade diagnosis.

Benefits of the ESD for a sustainable land use management
To conclude, the *Extended Spade Diagnosis ESD* may facilitate a sustainable soil management. Information for decisions on tillage and intercropping can be provided in detail to support the soil structure. The ESD is a tool which allows combined information on an aggregated indicator of soil stability as well as the evaluation of the soil structure. This provides *knowledge on the actual tendency of soil to erosion and compaction*. The ESD is also helpful to evaluate the infiltration capacity and the capability of a soil to filter water for a high-quality groundwater. ■

Publications and links to the Extended Spade Diagnosis (ESD) see www.gesunde-erde.net

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Wind erosion in the Wielkopolska region of West Poland

Wind erosion has become an increasingly severe problem in the present soil forming process occurring in the lowland areas of Central Europe (Riksen, De Graaff 2001). It is estimated that 16% of the arable area in Poland are subject to strong and very strong wind erosion. In the Wielkopolska region (central-west Poland, app. 30 000 km^2 of area), 17.5% of the arable land (316 000 ha) suffers from wind erosion.

by Prof. Stanislaw Podsiadlowski, Institute of Agricultural Engineering, August Cieszkowski Agricultural University of Poznan, Poland & Alfred Stach, Institute of Quaternary Research and Geoecology, Adam Mickiewicz University, Poznan, Poland

Conditions for wind erosion in the Wielkopolska region

The Wielkopolska and Kujawy regions are progressively evolving into steppe. This is caused by an excessive deforestation and a faulty drainage which in turn deteriorates the water balance. These processes are considered to be the main reason for the increase in wind erosion in combination with insufficient tree barriers and the rise of machinery in agriculture. As the mechanization and the effectiveness of cultivation have increased, the size of agricultural patches has expanded and trees alongside roads and agricultural land were removed. The menace of severe wind erosion has increased. Research was undertaken to determine the influence of mechanical cultivation on the wind erosion. These studies revealed that wind erosion processes in the *Wielkopolska region* mainly take place on light soils with a low mechanical strength of the soil structure. Soil erosion effects are mainly determined by the particle size distribution, specifically by the clay content. Soils are subject to wind erosion when the natural wind energy is reinforced by the additional energy of tillage. The wind erosion is high during shallow tillage treatments at a low soil moisture level.

Tillage-induced wind erosion (pulverizing erosion) on a field near Poznan city. Photo: S. Podsiadlowski

The extent and temporal variability of the aeolian erosion is largely determined by the wind regime. The north and the central part of Poland are most severely affected by the activity of the north-west cyclonic circulation, when Europe is under the influence of a deep and extensive low pressure system with the centre at Scandinavia. The weather in Poland is determined by quickly moving secondary systems which move across the south Baltic area leading to the formation of very strong winds.

The mean annual wind-speed is not at a high level in the vicinity of Poznan (the capital city of the Wielkopolska region) – a mere 4 m·s^{-1}. The highest velocities are recorded between November and April, when fields either have no plant cover at all or a very scanty one. During the year, there are more than 50 days when wind speeds exceed 10 m·s^{-1}, and about 3 days on average with winds of 15 m·s^{-1}. Prevailing winds are from the W and SW (in total, over 1/3 of the year). Westerly and north-westerly winds are also quite strong. They are especially frequent in December and January. In March, also strong easterly winds are recorded with a high frequency. Important factors of wind erosion in the Wielkopolska region are also relatively low precipitation totals (500 - 550 mm) and frequent early-spring droughts.

Effects of wind erosion

Long term measurement was established in the Wielkopolska region in 1986. Data indicate that the intensity of wind erosion on light soils ranges from 5 to 20 t·ha^{-1} per year with a very high spatial and temporal variability. Soil removed from fields is deposited along roadside shelterbelts typical for the Wielkopolska landscape. The direct effect of wind erosion is that drainage ditches are covered up by dust.The indirect effect of wind erosion is a clear change in the size distribution of soil aggregates and the humus content in the cultivated soil layer of an eroded field. In certain cases, the physical degradation of soil hampers a proper utilization of land. The intensity of pulverizing and wind erosion in Central Poland displays the very high spatial variability, even within small patches of land (Stach, Podsiadlowski, 1998, 2002). This is caused by the polyfractionality and diversity of the morainic deposits that form the soil bedrock. Wind erosion further increases a high natural soil variability. Agricultural productivity is directly affected by the high variability in texture and humus content as well as by the derivative physical and chemical characteristics of soils. Therefore, the potential to obtain a maximum yield from optimal organic manuring is limited.

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Tillage system to prevent wind erosion of light soil

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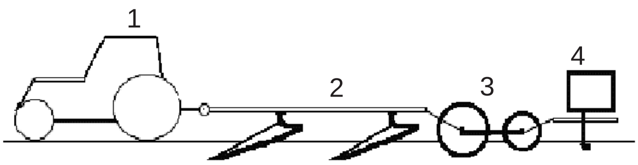
Problem
In the Wielkopolska region we experience a considerable increase of wind erosion especially in the season of pre-sowing tillage which is accompanied by the low crushing strength of the aggregate structure. The author made an attempt to determine the influence of mechanization on the process of wind erosion. Previous research has indicated several reasons for the susceptibility of the loamy sand soil to wind erosion (Podsiadlowski, Hagen 1998). These reasons include:

- The aggregate structure of these soils has a generally low mechanical stability.
- Conventional methods of tillage of loamy sands transfer a great amount of unitary tillage energy (kJ·m^2) to the weak aggregates near the soil surface.
- This large input of unitary tillage energy deteriorates the soil aggregate structure and pulverizes the surface soil, especially under conditions of low soil moisture.

Another challenge in managing these sandy loam soils is that they typically have low natural porosities that range from about 30 to 35 %. In fact, Poland only possesses small areas of soil with high natural porosities (Sklodowski, LLSN 6, 2003). However, due to low natural porosities, minimum soil cultivation lowers the production of many of the crops traditionally grown on these soils, such as potatoes, sugar beets and barley.

The integrated tillage system. Photo: S. Podsiadlowski



The components of the integrated tillage system:
1 Tractor
2 Mouldboard plough
3 Rollers
4 Sowing machine

Objectives
The first objective for the proposed tillage system was to minimize the soil aggregate pulverization from the input of unitary tillage energy (kJ·m^{-2}) that causes subsequently wind erosion. A second objective for the tillage system was to provide sufficient soil porosity in the tillage layer for optimum crop growth. Previous research has shown that, before tillage, the stability of the aggregates has typically increased with depth below the surface in the tillage zone. Hence, a soil inversion tool, such as a mouldboard plough, can both increase the soil porosity and bring the aggregates with the highest mechanical stability to the surface.

Results and impacts
To achieve these objectives, an integrated tillage system for the cultivation of sandy soils was developed to perform ploughing, presowing, and sowing operations simultaneously during a single tractor passage (see photo and figure, Podsiadlowski, Hagen, 2000).
The integrated tillage system was expected to have the following advantages:
- the farm tractor generally would only move on soil with a coherent/homogeneous structure and, thus, minimize the destructive effects of compaction energy transmitted by the tractor wheels; moreover, any surface aggregates pulverized by the tractor wheels would be moved to the bottom of the tillage layer by the plough;
- the overall porosity created in the tillage layer could be near the optimum value for most crops, especially during germination and emergence;
- the unitary tillage energy required for crop production could be lower than that in the conventional tillage system;
- both the soil fraction and the mechanical stability of non-erodible aggregates would be higher in the near-surface soil than those with the conventional tillage system.

Changes in the surface soil structure created by the integrated system have reduced the potential wind erosion in spring by more than 85 percent and have nearly eliminated the fall erosion hazard that occurs with the conventional tillage system.
In all our experiments, the highest crop yields were obtained with the integrated tillage system. The favorable soil conditions created by that system were also manifested in the tallest crop heights. In contrast to this, both the lowest crop heights and lowest yields occurred with the conservation tillage system. The integrated tillage system used over 30% less fuel than the conventional tillage. Although the conservation tillage system was characterized by the lowest crop yields, it required 17 to 27% less fuel than the integrated tillage system.

Goals and tasks for the future
Based on these research results, the adoption of the integrated tillage system is recommended for loamy sand soils with low natural porosities because it increases crop yields and reduces both the fuel consumption and a potential wind erosion compared with the conventional tillage system. ■

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Wind erosion prediction

Simulations of the pulverizing and wind erosion were performed with the help of the *Pulverizing Erosion Prediction Model (PEPM*, Podsiadlowski, 1997). The PEPM was created with the purpose to facilitate the prediction of the intensity of pulverizing erosion occurring as a result of tillage on light soils at a low level of soil moisture. The PEPM includes three sub-models:

- to predict the expenditure of unit tillage energy,
- to predict the intensity of pulverizing erosion and,
- to predict the intensity of wind erosion.

The calculated pulverizing erosion intensity was compared with the data of direct measurements (Stach, Podsiadlowski 2002). The method used is based on the continuous measurement of air dustiness in specified points of a tractor-tool unit (Podsiadlowski et al., 1997):

- A good agreement between a simulated and measured average pulverizing erosion was noticed, both in the trends and with absolute values. The determination coefficient was 69%.
- The erosion values simulated with the PEPM were higher than the average measured in the accumulation zones of fields and lower in the erosion ones.
- The variability in the magnitude of the model-estimated erosion between zones was very small – only 5.4%. The difference between the average measurement results was much bigger – 31.7% – and including standard deviation range equaled 110%. ■

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DAPHNE's achievement for sustainability in Slovakia

DAPHNE's ultimate goal is to improve biological diversity and to renew the harmony between man and nature while conserving and restoring the integrity of Central European ecosystems. Concerning soil erosion, ecological and scientific techniques and measurements are provided for the Jaslovske Bohunice region of Slovakia.

by Jana Ruzicková & Tamara Rehácková, Comenius University, Faculty of Natural Sciences, Bratislava, Dobromil Galvánek, DAPHNE-Institute of Applied Ecology, Bratislava, (SK)

The DAPHNE Institute of Applied Ecology is a non-profit organisation founded in 1993. It has expanded from a scientific organisation focused on applied ecology and research to a nature conservation organisation with activities aimed at increasing the public's knowledge and understanding of the environment.

DAPHNE is implementing projects focused on the conservation of grassland and wetland ecosystems throughout Slovakia. Our expert team determines optimal restoration and management plans based on findings of scientific research. These plans are implemented with the close co-operation of local people. An important part of our projects is also influencing national and local policy towards nature conservation and making environmental issues easily understandable and accessible. Through its many projects DAPHNE has developed a collaborative network across universities, institutes and environmental organisations both on a national and an international level.

DAPHNE will achieve its mission by:

- applying ecological and scientific techniques to restore degraded ecosystems,
- solving conflicts between nature conservationists and other stakeholders,
- influencing the development of policy and legislation that is beneficial to nature conservation,
- increasing knowledge, promoting values and encouraging public participation and responsibility in nature conservation,
- encouraging co-operation between private and public institutions locally, nationally and internationally. ■

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Protection measures against erosion in Jaslovske Bohunice region

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Problem / Introduction

The cadaster of *Jaslovské Bohunice* is located in the agricultural landscape of the Trnava upland (part of Pannonian lowland) in the SW part of the Slovak Republic. The mapping of land use and biotopes in the region was carried out in 1998. Arable land covered 87.6% of the area, small forests and river bank forests were 1.6%, grassland 0.1%, urban area 3.8% and other areas 1.7 % of the area. The rest (5.2% of the area) is built over by a nuclear power plant. There are localities with an intensive and some with a very intensive wind erosion in the area of Jaslovské Bohunice (Bucko, 1990).

Objectives and methods

It was one of the main goals of *"The plan of ecological restoration in the cadastres Jaslovské Bohunice and Radosovce"* to solve problems with wind and water soil erosion (Ruzicková, Galvánek et al. 1999). The plan started with data on natural conditions and then proceeded with the analysis of historical and recent land cover, the mapping and research of valuable biotopes and with data of fauna and flora. The analysis of land use during the last 260 years was prepared in GIS using historical and cadaster maps combined with the results of mapping in the field.

Afterwards, the initial plan *"The realisation project of the protective forest strips with a soil protecting function in the cadaster of the Jaslovské Bohunice village"* was elaborated (Ruzicková, Rehácková, Galvánek 2000). It designed the most suitable composition of plant species, planting technique and a sort of maintenance for proposed restoration measures.

Results and impacts

The results of field work and data analyses have shown that the network of natural elements in the Jaslovské Bohunice area is insufficient. Existing ecologically valuable biotopes cover only 1.6% of the territory. Most of them are linear structures. They are especially represented by: a) water streams, b) linear vegetation in the agricultural landscape, c) alleys along field roads. Forest and grassland biotopes, mostly oak forests with oak-turkey and oakhornbeam forests, are generally missing there. On the other hand, a historical analysis revealed that the agricultural use has been the dominant type of land use in the region for hundreds of years. This fact has to be taken into account for any measures. The plan of ecological restoration was proposed in several steps:

- Protection of existing valuable biotopes. If necessary, a change or enhancement of plant species composition and the regulation of invasive plant species are proposed.
- Planting of new natural elements with different functions as: biotopes, connective elements and protective strips against soil wind and water erosion. Linear elements with different width were proposed:
  - 5 m (overall length 9,320 m),
  - 7 m (overall length 17,900 m) and
  - 10 m (area 7,026 ha).

  The target species composition is based on the potential natural vegetation. The area of natural elements in the cadaster of Jaslovske Bohunice should be increased from 1.6% to 6%.
- Proposal of recreational greenways with an information about the natural and historical values of localities.

Limits to the realization of the project

The area of Jaslovske Bohunice was proposed as one of the pilot areas in Slovakia where the sources from the pre-accession EU fund SAPARD should be spent for agri-environmental measures. However, the proposed scheme for the establishment of a non-forest tree vegetation could not be applied in the area of Jaslovske Bohunice. This was due to the underestimation of the needed amount of subsidies for the scheme and also due to several methodological restrictions, which disqualify regions with a very intensive agriculture from the agri-environmental programme. ■

Current view on intensively used agricultural land around the power plant in Jaslovske Bohunice.

Graphic showing how the view could look like, if the restoration plan was implemented. Both photos: DAPHNE

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Gully erosion in vineyard areas of the NE Spain Mediterranean region

Gully erosion, defined as erosion in channels where runoff water accumulates and removes soil from this channel area to considerable depths, is a serious problem in many parts of the world because of climate, lithology, soils, relief and land use/cover characteristics. Although in relation to other erosion processes, as sheet or rill erosion, gully erosion has been missed in most cases until recently, some studies have confirmed that this type of erosion contributes significantly to the total soil loss: between 44 - 83% of the total sediment production in agricultural lands. Therefore, gully erosion in any of its forms should be neither neglected nor considered to be a minor omission.

by Dr. José A. Martínez-Casasnovas, Associate Professor, & Dra. M. Concepción Ramos, Associate Professor, University of Lleida, Department of Environment and Soil Science, Lleida, Spain

The Mediterranean area is amenable to gully erosion due to the seasonality and the erosive character of rainfalls and other lithology and land use characteristics. In this region, vineyards are one form of land use that cause the highest soil losses owing to their partial soil covering. This article illustrates this type of soil erosion problems with the example of the Penedès region, which is a reference vineyard area of the NE part of Spain in which the land use is changing from traditional cultivation to mechanized cultivation produced by erosion control measures in the last decades. This change was an additional factor that has affected the soil erosion balance.

The Penedès Vineyard Region and gully erosion types

The Penedès Vineyard Region is located in Catalonia (NE Spain), about 30 km south west of Barcelona. This region is mainly dedicated to vineyards for the production of high-quality vines and *"cavas"* (sparkling wines produced by the champagnoise method). The area is part of the Penedès Tertiary Depression, where calcilutites (marls) and, occasionally, sandstones and conglomerates outcrop. The climate is Mediterranean with a mean annual temperature of 15º C and a mean annual rainfall of 550 mm. The rainfall mainly occurs in two periods: September to November and April to June. *High-intensity rainstorms* are frequent during September to November (e.g. >100 mm h^{-1} in 5 min periods).

One of the main characteristics of the study area is the dissection of the landscape by a dense and deep network of large gullies that affect between 15 to 27 % of the land. The maximum depth of gullies varies between 20-50 m and they have a width of between 50 – 350 m. The crosssectional shapes of the gullies are V- to U-shaped with maximum sidewall slope angles of 78º. Inter-gully areas are usually undulating to rolling although at present they are intensively levelled, due to land transformations to favour mechanization, and planted with drained vineyards. In these areas, a concentrated overland flow causes the incision of ephemeral gullies, which can easily be obliterated by normal tillage or filled by farmers. However, if not controlled and since these small channels have an impact again and again at the same locations by additional runoff events, they may grow into large gullies.

Erosion processes and rates

Erosion rates in this gully system have been assessed from different perspectives using multidate aerial photographs, multi-date topographical surveys and multidate *Digital Elevation Models (DEMs).*

A recent study in this gully system (Martínez-Casasnovas et al., 2003) has shown that the sediment production rate (SPR) in large gullies during the period 1975 – 1995 was 846±40 Mg ha^{-1} yr^{-1}, with a neat erosion of 576±58 Mg ha^{-1} yr^{-1}, which is a sediment delivery ratio of 68%. The average rate of *sidewall retreat* equals 0.1 m yr^{-1}. Most of this erosion occurs on gully walls by sidewall processes. The sediment mobilised from the gully walls is usually removed by a concentrated runoff during high-intensity rainstorms. In other cases, this sediment is deposited on the gully bottom, which may lead to the aggradation of the gully bed. Mass movement produces the reshaping of sidewalls by the development of vertical fissures in the marls that crop up at the gully walls.

Soil losses at vineyard field level by ephemeral gully erosion, which is mainly produced by an extreme rainfall event, occurred in Catalonia on 10th June 2000 and have also been measured by the subtraction of multi-date detailed DEMs before and after the rainfall event (Martínez-Casasnovas et al., 2002). This event registered 215 mm, 205 mm of which fell in 2h 15min, with a maximum intensity in 30-min periods of up to 170 mm h^{-1}. The results show that 487±13 Mg ha^{-1} of the soil were mobilised by the generated surface runoff. Most of this sediment (58% of the total soil detached) was produced by a concentrated surface runoff which developed ephemeral gullies in topographic depressions within the plot. The neat erosion in the study vineyard field was 207±21 Mg ha^{-1}. This research also revealed the importance of maintaining soil and water *conservation measures*, as for example hillside ditches or broadbase terraces in vineyard fields. These structures help by retaining sediments within the vineyard fields (up to 23% of the total deposits produced). ■

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Gully erosion prevention in vineyard parcels in the Penedès area of Spain

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Problem

Most of the erosion that occurs in large gullies of the *Penedès Vineyard Region* is influenced by runoff water that is generated on the neighbour vineyard fields. In these fields, about 58% of the sediments generated during high intensity rainfalls are due to a concentrated surface runoff, which causes an important surface lowering (ephemeral gullies) up to 0.4 - 0.5 m in some parts of the fields (see photo). Ephemeral gullies can easily be obliterated by normal tillage or filled by farmers because the scoured soil volume usually is not very large. However, if not controlled, and since those small channels reform again in the same locations by additional runoff events, they may grow into large gullies producing significant local topographic changes in the medium and in the long run.

Ephemeral gully after a high intensity rainfall event in a vineyard field of the Penedès region. Photo: J.A. Martinez

A control measure for ephemeral gully erosion is to intercept the runoff along the field's slope and to convey it from the parcel to the main drainage system. This has been traditionally done by means of hillside ditches (broad-base terraces) that run along the contour of the vineyard plantations. However, in the last decades, in most of the new vineyard plantations, adapted to facilitate crop mechanization, traditional conservation measures as hillside ditches have been usually removed resulting in an increase of soil erosion.

Objectives

The main objective of this research is to assess and to demonstrate the importance of implementing and maintaining drainage structures, like hillside ditches, in new vineyard plantations of the Penedès region in order to avoid major soil losses mainly caused by the development of ephemeral gullies. Two assessments were carried out, one referred to a traditional vineyard plantation and another to a new vineyard.

In the traditional vineyard, some evaluations were done to understand the effectiveness of the hillside ditches and to avoid soil losses by rills and ephemeral gullies higher than a threshold value. This was defined as the highest acceptance tolerance limit for this area. In the new vineyard, with an average slope of 8.9%, consisting of drained vines which run along the contour (perpendicular to the maximum slope degree direction), the effect of hillside ditches was evaluated. The analysis period covers the period from 17/3/2000 to 20/6/2000, in which total rainfall was mainly concentrated in an extreme rainfall event which occurred on 10/06/2000 (214.6 mm fell within one day) representing 44% of the mean annual precipitation. This event caused a major soil loss estimated in 207±21 Mg ha^{-1} (Martínez-Casasnovas et al., 2002).

Results

In the traditional system, the assessment shows that the distance between terraces should not exceed 28m in fields with an average slope of 6% and 20m in fields with an average slope of 8% to avoid soil losses of more than 11 Mg ha^{-1} $year^{-1}$, which is the tolerance limit established for the area (Ramos and Porta, 1997). For the new vineyard, it shows the altitude difference in the case study vineyard field between 17/3/2000 and 20/6/2000, before and after the registered extreme rainfall event. It shows the development of ephemeral gullies (negative differences) as well as the deposit of sediment in different parts of the field. As can be seen, the sedimentation zones are mainly located along the hillside ditches, which intercept a part of the runoff and of the sediment generated above them. During the analyzed extreme rainfall, the hillside ditches trapped about 65±1 Mg ha^{-1} (23% of the sediments deposited within the field). This sediment was later mainly redistributed to fill the ephemeral gullies developed. In the absence of hillsides, most of the sediments would have been transported out of the plot via the ephemeral gullies and the total soil loss would have increased by about 32% compared to the currently observed level.

Recommendation

The present work underlines the necessity of a good planning of soil conservation measures in new vineyard plantations of the NE Spain Mediterranean area as well as the importance of maintaining the ones existing in present plantations instead of the extended practice during the last years which proposed their elimination in favour of vineyard mechanization. ■

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Natural regeneration potential and soil erosion risk after forest fires in typical Mediterranean areas

Deforestation caused by wild forest fires is a major factor contributing to soil degradation in Mediterranean areas. The main goal of this research was to explore the ability of satellite remote sensing in monitoring and of evaluating natural regeneration and other relevant processes as well as of mapping vegetation species after forest fires. An experimental physical model for predicting the sustainability of typical Mediterranean forest areas after fires was also studied.

by Prof. Dr. Demetrius Rokos & Pol Kolokoussis, Laboratory of Remote Sensing, National Technical University of Athens, NTUA, Athens (GR)

Problem / Introduction

This research has been carried out in the framework of the European Environment Agency EEC project *"A GIS Decision Support System for the Prevention of Desertification Resulting from Forest Fires"* in cooperation with the National Agricultural Research Foundation (NARF, Greece), the University of Surrey (UoS, United Kingdom) and the Institute for Digital Image Processing (DIBAG, Austria).

Forest fires constitute a major problem in Mediterranean countries especially during the summer. For the last three decades, forest areas of Greece, particularly in the Prefecture of Attica, have repeatedly suffered wild forest fires. Deforestation caused by forest fires, is a leading factor contributing to soil degradation. The determination of areas with a low potential for natural regeneration and a high risk of soil erosion and thus, under serious threat of future desertification, is of critical importance in decision-making procedures for forest environment protection measures such as reforestation, fortification works for the prevention of erosion caused by rain and grazing control. Due to the different physical and other factors, which characterize and affect each area, different types of vegetation reappear after forest fires while a wide spatial variability in the natural regeneration evolution is observed. As documented in previous relevant studies, a monitoring of the natural regeneration of forest vegetation using satellite remote sensing imagery is possible.

Wild forest fire in the Greece Mediterranean. Photo: NTUA

Objectives

Depending on the climatic, topographic, geological and human factors affecting each site, the natural regeneration processes may be very slow while vegetation reestablishment on a site with absence of vegetation for more than three years is almost impossible. Such a situation could be caused by the recursive burning of a forest area, soil erosion or a lack of rain.

A model capable of predicting sites with a low potential for natural regeneration and a high risk of soil erosion in a burnt forest area would be very helpful for preventing possible desertification processes.

The main objectives of this research were

- an accuracy assessment of vegetation status monitoring which may be achieved using satellite remote sensing imagery and relevant methods and techniques;
- the introduction and evaluation of a model capable of predicting natural regeneration and soil erosion processes.

Data collection

A series of LANDSAT TM images has been acquired and used in this project for the years 1984, 1987, 1988, 1990 and 1993. The images taken in 1984 and 1987 were the most appropriate for identifying burnt areas and estimating the vegetation loss as most forest fires occurred in 1985. The 1993 scene was taken close to the date when the training data were collected and thus was the most appropriate scene in order to generate the natural regeneration potential map, the erosion risk map and the vegetation status map.

Field data were collected for 39 training and 14 test sites concerning: elevation (m), aspect, slope (%), relief, physiography, surface geology, soil depth (cm), surface soil colour, surface soil texture class, surface rockiness & stoniness (%), degree and extent of fire (%), presence or absence of burnt trees, average height / density / leaf colour and percentage of area covering of new vegetation for the three major vegetation types (Aleppo pine, maquis and phrygana) of the study area, human influence(s) on the vegetation after the fire (mainly animal grazing), desertification hazard, characteristics of the area surrounding the test sites. Moreover, height and canopy closure for Aleppo Pine and undergrowth vegetation have been measured in 35 pure forest areas.

Results

The accuracy of several vegetation indices has been evaluated in estimating the vegetation density for the specific areas, satellite images and conditions.

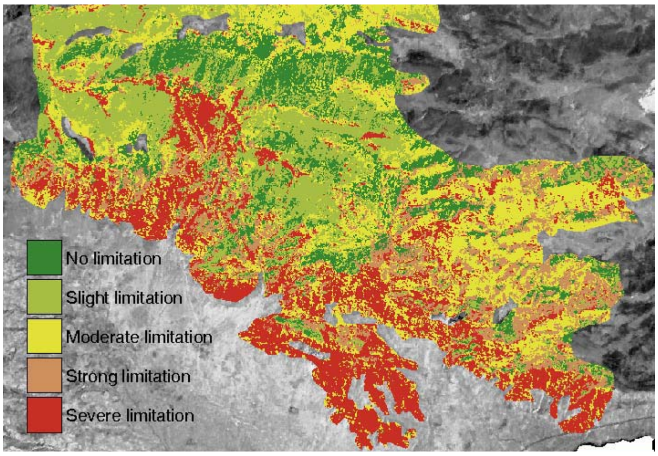
For the identification of the three major vegetation types encountered in the study area (Aleppo Pine, Maquis and Phrygana) multiple bands or transformations of the LANDSAT TM have been used. The statistical analysis revealed that Principal Component 3 (PC3) had the highest correlation with the percentage of Phrygana and Maquis in the training sites, PC2 had a significant correlation with the percentage of Aleppo Pine and NDVI was more sensitive to the percentage of Aleppo Pine, Maquis and Bare Soil or Rocks. A standard maximum likelihood classification involving principal components 2, 3 and NDVI was performed. The classification turned out to work quite well with an overall accuracy of 86% for the major vegetation types in each site. An experimental model for predicting the natural regeneration potential and the risk of soil erosion has been generated.

The model consists of three simple rules which are based on the experience of our forestry expert colleagues.

The first rule takes the soil depth class (related to soil water storage capacity) and the aspect of a site into consideration and gives five classes of natural regeneration potential based on the following assumptions:

- Deep soils store more water and usually carry more dense and a taller vegetation than shallow soils. The origin of soil parent material (surface geology) is indirectly manifested through the soil depth.
- Vegetation in areas directed to the south is usually more sparse and shorter than similar vegetation which is in areas directed to the north. This happens because areas directed to the south receive a larger amount of solar energy and thus tend to be drier.

Soil depth	Aspect	Natural regeneration potential
>30cm	North	No Limitation
>30cm	South	Slight Limitation
5-30cm	North	Slight Limitation
5-30cm	South	Moderate Limitation
<5cm	North	Strong Limitation
<5cm	South	Severe Limitation



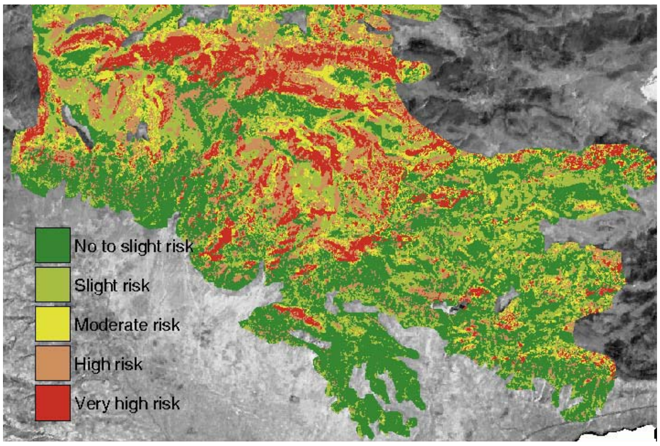
Natural regeneration potential map for the area of Patera mountain. Laboratory of Remote Sensing, NTUA, Athens

The second rule considers three factors (permeability, soil depth and inclination) and determines five classes of soil erosion risk. *The third rule* determines the risk for future desertification as a function of the natural regeneration potential and the risk of soil erosion.

The following premises comprise the base of the soil erosion risk rule:

- Soils on permeable rocks are less sensitive to erosion than soils on impermeable rocks. Similarly, deep soils, due to their larger water storage capacity, are less sensitive to erosion than shallow soils.
- The erosion risk is higher in slopes that are steep than in slopes that are flat.

Permeability	Soil depth	Slope (%)	Soil erosion risk
Bare rocks	-	-	No - Slight
Permeable	> 30 cm	< 20	No - Slight
Permeable	> 30 cm	> 21	Slight
Permeable	5-30 cm	< 20	Slight
Permeable	5-30 cm	> 21	Moderate
Impermeable	> 30 cm	< 20	Slight
Impermeable	> 30 cm	21-40	Moderate
Impermeable	> 30 cm	> 41	High
Impermeable	5-30 cm	< 20	High
Impermeable	5-30 cm	> 21	Very High



Soil erosion risk map for the area of Patera mountain. Laboratory of Remote Sensing, NTUA, Athens

The above model ignores weather conditions (mainly rainfall) which affect the regeneration process and erosion due to rain. It is assumed though that there has been sufficient rain and that all sites have received rainfall with the same characteristics in terms of intensity and distribution pattern. Furthermore, the proposed model ignores human factors (mainly animal grazing) which have proved to be quite important to be left aside.

The functionality of the described model depends on the availability of the data necessary. Data on slope, soil depth, surface geology are necessary to use the proposed model. Aspect and slope layers may be easily produced using the DEMs of the study areas. Data on permeability may be obtained by digitalizing the existing geological maps. The depth of soil may be obtained from detailed soil maps, which, unfortunately, are usually not available or not enough detailed for most Mediterranean regions.

As an alternative, the soil depth could be estimated by indirectly using satellite images. In arid and semiarid regions, in the dry season, the amount of green biomass mainly depends on the quantity of water available to the plants. Thus, the soil depth (related to the water storage capacity of a soil) in the dry season, is highly related to the density of vegetation in the area, while less than 50% should be related to the type of vegetation. Such a strong relationship between soil depth and vegetation density is encountered when the maximum possible amount of vegetation is present in the study area.
In this project, two approaches have been applied: a purely GIS approach with the use of existing maps; a hybrid remote sensing & GIS approach with the use of existing maps combined with the soil depth calculated by using satellite imagery. In the latter case, the soil depth was calculated from a satellite image acquired before the forest fire events.

Goals and tasks

Maps of vegetation species, vegetation density, natural regeneration potential and risk of soil erosion have been successfully produced for the study areas of the project. Ten years after the project completion, the evaluation and correction of the natural regeneration potential and soil erosion risk maps which have been produced will be an important task in order to assess the actual accuracy of the model predictions. ■

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Forest fires in the Mediterranean – a burning issue

The Mediterranean region is heavily affected by forest fires; every year more than 50,000 fires burn an estimated average of 600,000 - 800,000 hectares, an area comparable to the island of Crete or the island of Corsica and equal to 1,3 - 1,7 % of the total Mediterranean forests. (...)
While small-scale fires may be part of the natural dynamics and the management of the natural resources, large-scale forest fires throughout the region have dramatically increased during the last few decades, mainly as a consequence of the rapid land-use changes, socio-economic conflicts and competing interests characterising the Mediterranean region in the last decades.
As a result of the intensification of forest fires, the capacity of the Mediterranean ecosystems to naturally regenerate in many areas has been reduced, while extensive areas are being affected by biodiversity loss, soil erosion and water scarcity. Indeed, forest fires aggravate soil erosion leading ultimately to desertification. This also leads to huge economic costs.
The risk of forest fires is further aggravated by the current climate change trend in the Mediterranean region, which is also reducing the capability of Mediterranean forests to accommodate them.
The current climate change trend in the Mediterranean is provoking longer summer droughts and intensification of these droughts even out of season. Also, extreme weather events, such as periods of high temperatures, strong air dryness and very strong winds as well as sudden storms with heavy rainfall in only a few hours (an amount similar to the annual average rainfall in some areas) are becoming frequent. As a result large-scale forest fires are fostered, with consequent soil erosion in burnt areas further aggravated by the heavy rains.

Concrete priority actions needed

- Integrating an adequate forest fire risk assessment in all development plans related to sustainable rural development as part of preventive measures.
- Introducing effective environmental and rural measures within agricultural policies to promote the development of functional landscapes, in which sustainable agroforestry systems and highly valuable forests were able to reduce the vulnerability to fires.
- Evaluation of the total economic costs of forest fires. Both direct and indirect loss including natural resources and biodiversity as direct losses and ecological degradation, water shortage, soil loss and many other aspects as indirect losses.
- Serious commitment from governments to determine the causes of all forest fires, to identify those responsible and to make sure that costs of the damage are recovered.
- Naturally regeneration and plant covering of burnt areas to prevent soil erosion and land degradation.
- Reinforcement or establishment of adequate laws and regulations prohibiting forest land conversion to urban use after fires, regulating burnt wood in the timber market to avoid price speculations and reforming agricultural regulations to manage fire use and burning practices, preventing the use of these practices in sensitive areas or during the high fire risk season.
- Awareness-raising campaigns targeted to different sectors of society (tourists, land owners, farmers, shepherds, etc) and educational activities (i.e., training about forest values and appropriate behaviour to prevent fires and react after fires have started) to foster active participation.

Maßnahmen zum Abbau der Erosion – Vorschläge von ELSA e.V.

Die vorliegende Ausgabe von local land & soil news zeigt die Bedeutung und die Tragweite der Erosionsproblematik in verschiedenen Ländern und Regionen Europas und über jene Grenzen hinaus in vielfältigen Formen und mit unterschiedlicher Wirkung. Davon betroffen sind Mensch und Umwelt in wichtigen Bereichen der Kulturlandschaft, der Gebirgswelt, der Küsten, der Wälder, der Steppen, wie auch der Siedlungsgebiete. Aus den zahlreichen „*good practice*" Beispielen in diesem Heft und in Ergänzung dazu, haben wir einige konkrete Maßnahmen herausgearbeitet, die unter den spezifischen Gegebenheiten vor Ort in den Kommunen und Regionen umgesetzt und angewendet werden können.

1. Maßnahmen in der Landwirtschaft
- im *Ackerbau:* geeignete Fruchtfolgebewirtschaftung (Haupt- und Zwischenfrüchte), um die Bodenbedeckung zu optimieren, schonende Bodenbearbeitung (Vermeiden von Bodenverdichtung), um die Stabilität und Sickerfähigkeit der Böden zu erhöhen;
- in der *Weidewirtschaft* und im *Almwesen:* geeignete Schlageinteilung und Besatzgrößen, um Verbissschäden der Grasnarbe und Trittschäden zu vermeiden;
- im *Rebbau:* Bodenlockerung und Gassenbegrünung, in steilen Hanglagen Zwischenterrassierungen und hangparalleler Anbau, um Abschwemmungen zu verhindern;
- im *Landwirtschaftsbetrieb generell:* Anlage und Pflege von Feldgehölzen (Hecken und Bäumen), um Rutschungen zu verhindern und Böden vor Winderosion zu schützen, Niederquerschnittsbereifung bei Zugmaschinen, um weitere Bodenverdichtung zu vermeiden.

2. Maßnahmen im Forstwesen
- in *Schutzwäldern:* nachhaltige Waldpflege (Verjüngung), um die Schutzfunktionen des Waldes, vor allem im Gebirge und in Gefahrengebieten, dauerhaft zu gewährleisten;
- bei der *Waldbewirtschaftung generell:* Förderung von Mischbeständen, abgestuften Waldrändern mit vorgelagerten Büschen und Sträuchern, Vermeidung von Waldrodungen, bodenschonende Waldbewirtschaftungstechnik, insbesondere bei Abholzung und Abtransport;
- bei *Aufforstungen:* standortgerechte Baumartenwahl und systematische Auslichtung, um die Gesunderhaltung der Bäume und damit eine hohe Bodenstabilität zu gewährleisten.

3. Maßnahmen im Hochwasserschutz und Wasserbau
- im *Hochwasserschutz:* Förderung präventiver Versickerung und Speicherung von Regenwasser in Böden, beispielsweise durch Entsiegelung versiegelter Flächen, Bodenlockerung bzw. Vermeidung von Bodenverdichtung kultivierter Flächen, nachhaltiges Flussraummanagement, um Flüssen mehr Raum zu geben, insgesamt erosionsmindernde Vorkehrungen, die im Postitionspapier ELSA e.V. (2002): „Bodenschutz ist vorsorgender Hochwasserschutz" vorgeschlagen sind;
- im *Wasserbau:* möglichst natürliche Renaturierung von verbauten (eingedolten und kanalisierten) Gewässern, weitgehender Verzicht von Wildbachverbauungen;
- im *Gewässerschutz:* Schutz und Unterhalt von Oberflächengewässern, natürlichen Flussauen, See- und Flussufern, Bächen, um den Abfluss und den Pegelstand zu regulieren.

4. Maßnahmen im Bauwesen
- im *Siedlungsbau:* Verbot von Bauten in Gefahrengebietszonen und in rutschgefährdeten Gebieten, sickerfähige und bodenstabilisierende Umgebungsgestaltung;
- im *Wege- und Strassenbau:* Minimierung von Eingriffen in rutschgefährdeten Hanglagen, natürliche Befestigung von Böschungen durch standortgerechte Artenwahl bei Einsaat und Bepflanzung, Abstützung mittels natürlicher Baustoffe.

5. Maßnahmen in Tourismusgebieten
- in *Skipistengebieten (Wintertourismusgebieten):* Vermeidung von Geländeplanierung (Bodenabtrag, Einebnung, Aufschüttung), sachgerechte Pistenpräparierung, um Schädigungen der Pflanzendecke und Bodenverdichtung zu vermeiden, Verzicht von Waldrodung (Waldschneisen) in rutschgefährdeten Steilhängen, sachgerechte Wiederherstellung der Pflanzendecke mit standortgerechter Artenzusammensetzung;
- in *Wandergebieten (Sommertourismusgebieten):* Anlage oder Umlegung von Wander- und Radwegrouten ausserhalb erosionsgefährdeter Gebiete.

6. Maßnahmen in Gefahrengebieten
- in *Gefahrengebieten generell:* Ausweisung von Gefahrenzonen, Anordung von Vorschriften und Schutzvorkehrungen;
- in *Hangrutschgebieten:* Bauverbote und Nutzungsvorschriften hinsichtlich der Erhaltung und Förderung einer optimalen Bodenbedeckung, Vermeidung von erosionsauslösenden Eingriffen und Aktivitäten, baulichen Maßnahmen, um Abrutschungen und Steinschlag zu verhindern;
- in *Lawinengebieten:* präventive Schutzmaßnahmen wie Lawinenverbauungen oberhalb der Waldgrenze und in offenen Gebieten unterhalb durch (Wieder-)Aufforstung von Schutzwald;
- in *Waldbrandgebieten:* primär durch Förderung des natürlichen Aufwuchses und gegebenenfalls Unterstützung mittels gezielter Aussaat und Bepflanzung von „klimaresistenten" Arten, bei Wiederaufforstung mit standortfremden Arten als Übergang (z.B. Schwarzföhre), langfristig die Rückkehr standortheimischer Arten (z.B. Steineiche) fördern;
- in *Küstengebieten:* dem Landabtrag durch Wellenschlag und Anstieg des Meeresspiegels (Folge der Klimaveränderung) möglichst durch naturnahe Vorkehrungen (z.B. Förderung der Ufervegetation durch gezielte Anpflanzung) entgegenwirken, strenge Wegleitung und Schutzbestimmungen, insbesondere an stark frequentierten Stränden.

7. Maßnahmen in weiteren empfindlichen Gebieten
- in *Sanddünengebieten:* Förderung und Schutz der natürlichen Dünenvegetation, spezifische Bepflanzung gegen Verwehungen, strenge Anweisungen zum Schutz der Dünen;
- in *Karstgebieten:* Aufforstung ursprünglich bewaldeter Gebiete, schonende angepasste Bewirtschaftung auf dünnschichtigen, kargen Böden;
- in *von Dürre und Trockenheit betroffenen Gebieten:* angepasste Formen der Landnutzung, nachhaltige Nutzung der Wasserressourcen zur Verbesserung der Bodenstruktur und der Bodenbedeckung mit standortgerechten Pflanzenarten in der Land- und Forstwirtschaft, präventive Maßnahmen zum Schutz vor Waldbränden;
- in *Gebieten mit empfindlichen Ökosystemen:* nachsichtige Behandlung, gegebenenfalls durch vollständigen Verzicht von Interventionen auf Pionierstandorten (z.B. Abtrag in Flussauen und mageren Trockenstandorten). ■

EU-Kommission will Europäische Bodenschutzstrategie im Jahre 2005 vorlegen

Am 19.04.2004 fand in Brüssel die *3. Sitzung des Advisory Forums* im Rahmen der Entwicklung der EU-Bodenschutzstrategie statt. Die Sitzung wurde von *Patrick Murphy* (Head of Unit, DG Environment) geleitet. Frau *Catherine Day* (Director-General of DG Environment) bedankte sich bei den Mitgliedern des Advisory Forums und der Technischen Arbeitsgruppen (TWG) für das gezeigte Engagement sowie Umfang und Qualität der erarbeiteten Dokumente. Dann erläuterte sie die Überlegungen der EU-Kommission zum weiteren Vorgehen hinsichtlich der Umsetzung der EU-Bodenschutzstrategie. Demnach plant die Kommission, ihre Mitteilung zur EU-Bodenschutzstrategie erst im Jahre 2005 vorzulegen. Die weitere Ausgestaltung und Umsetzung werde somit als Aufgabe der „neuen" Kommission verstanden.
Die Entscheidung, ob es zum Vorschlag einer Rahmenrichtlinie zum Bodenschutz kommen soll, oder ob eine Regelung im Rahmen einzelner Richtlinien erfolgen soll, sei noch offen. Unstrittig sei derzeit die Integration der Bodenschutzstrategie in diverse andere Politikbereiche. Genannt wurden u.a. die Bereiche Wasserrahmenrichtlinie, Meeresumwelt, Klimaschutz, Agrarpolitik, Industrieentwicklung, Forschung und Haftungsfragen. Jedoch soll die Bodenschutzstrategie in einem Paket verabschiedet werden.
Weiterhin bestehe Bedarf für die Verbesserung der Datenlage und die Notwendigkeit zu einer besseren Zuordnung der europäisch relevanten Fragen und jener Sachverhalte, die im Sinne der Subsidiarität besser auf lokaler oder regionaler Ebene zu regeln wären. Die Umweltdirektorin machte aber deutlich, dass die Vorstellung der Bodenschutzstrategie nicht das Ende der Bemühungen der Kommission um den Bodenschutz darstellen soll. Der eigentliche Schwerpunkt der Arbeit liege in der konkreten Umsetzung der Strategie.
Prof. Winfried Blum (TWG Research) wies in diesem Zusammenhang nochmals darauf hin, dass Bodenschutz nicht allein auf der Expertenebene realisiert werden könne, sondern dass dieser Ansatz auch durch verstärkte Bemühungen im Bereich der Bewusstseinsbildung und Ausbildung flankiert werden müsse. Als Zielgruppen wurden u.a. auch die Land- und Forstwirte genannt. Dies erfordere aber auch die Unterstützung der Mitgliedsstaaten. In diesem Zusammenhang unterstrich *Detlef Gerdts* (ELSA e.V.), dass die Wahrnehmung der Belange des Bodenschutzes vor allem auch im kommunalen Bereich verbessert werden müsse und sich das Boden-Bündnis dafür einsetzen werde. Das lokale Engagement soll nach Aussagen von Frau Day auch Gegenstand der Strategie sein und verwies auf die vorhandenen Programme. Bezüglich des Aufbaus von Netzwerken gäbe es derzeit noch keine konkreten Planungen.
Großes Lob wurde seitens der Mitglieder der EU-Kommission den ca. 400 ehrenamtlich zuarbeitenden Bodenexperten aus allen EU-Mitglieds- und Beitrittsländern ausgesprochen für die gelungene Zusammenführung des Bodenwissens. Es sei daher naheliegend, daraus eine stärkere Führungsrolle Europas für die Belange des Bodenschutzes abzuleiten. Die EU-Kommission bemühe sich derzeit verstärkt darum, zu vertieften Erkenntnissen über die Folgenabschätzung zu gelangen (Schäden bei Nichtstun versus Kosten für das geplante Handeln). Entsprechende Ergebnisse sollen zusammen mit der Strategie vorgelegt werden.

Informationen über den Sachstand der Bodenschutzstrategie und die Ergebnisse der einzelnen Arbeitsgruppen sind in der Kommunikationsplattform CIRCA SOIL abrufbar unter *www.forum.europa.eu.int/Public/irc/env/soil/library* ■

ELSA auf der Aalborg+10-Tagung in Dänemark

Mehr als 1000 Teilnehmer besuchten vom 8.–11. Juni 2004 die norddänische Stadt, in der 1994 die *Aalborg-Charta zur Nachhaltigkeit* entwickelt und verabschiedet wurde. Nach 10 Jahren haben mehr als 2000 europäische Gemeinden und Städte diese Charta unterschrieben und handeln mehr oder weniger entsprechend den eingegangenen Verpflichtungen.
Die Konferenz, die unter der Schirmherrschaft der Generaldirektion Umwelt der EU-Kommission stand, beschäftigte sich im wesentlichen mit den inzwischen eingeleiteten *Agenda21-Prozessen in Europa*. Da 56 % der Europäer in Städten wohnen, kommt dem nachhaltigen Umgang mit den Umweltmedien Boden, Luft, Wasser gerade hier eine große Rolle zu.
Zur Sprache kam aber auch die Sorge, dass in einer erweiterten EU dem Thema Schutz der Umwelt analog den Entwicklungen in den bisherigen EU-Ländern nicht mehr der Raum gegeben werden könnte wie bisher. Interessant in diesem Zusammenhang war auch die Zusammensetzung der Teilnehmer: Am häufigsten vertreten waren spanische, italienische und skandinavische Kommunalvertreter; Deutsche, Holländer, Österreicher und Schweizer fanden hingegen nur vereinzelt den Weg nach Aalborg.

Gut besuchter ELSA Stand in Aalborg. Foto: D.Gerdts

ELSA e.V. hatte zusammen mit dem Naturkundemuseum der Stadt Osnabrück, das für das geplante überregionale Bodenkommunikationszentrum (www.osnabrueck.de/unterwelten) warb, einen Gemeinschaftsstand, an dem sich viele interessierte Kommunalvertreter aus vielen Ländern über das Thema „Boden" informierten. ■

Detlef Gerdts, Vorstandsvorsitzender ELSA e.V.

To what extent are soil functions and soil performances – e.g. soil's performance concerning rain water infiltration – taken into account in planning procedures? How can existing soil data be used in planning procedures in order to enhance contributions to a sustainable development? How could a tool for soil evaluation applicable for planners in their everyday life look like? To all these questions, the EU-funded INTERREG III B project TUSEC-IP addresses – as an integrated and innovative approach to develop a soil evaluation system and to implement this tool in planning procedures.

A Project in Progress

The project TUSEC-IP which started in July 2003 has reached an especially busy stage in which work on seven different work packages *(WP)* is running parallel.
A comprehensive study of the legislation background of soil evaluation referring to legal regulations on soil protection, planning procedures and public participation in the involved countries Italy, Slovenia, Switzerland, Germany and Austria is just about finished *(WP "Legislation"*. The specific features of the legal framework reveal the opportunities and restraints for implementation and use of the soil evaluation system which has already been developed in its basic features *(WP "Evaluation Technique")*.
The TUSEC-IP evaluation technique provides two different levels resp. methods of evaluation: the so-called *"A-Level"* which refers to a scale larger than 1:10.000 – the legally binding planning level – as well as the *"B-Level"* which can be used to evaluate soil area-wide in the municipality (on overview scale of 1:10.000 - 1:50.000).
As TUSEC-IP follows an user-orientated approach the user requirements – needs, expectations, conditions for soil evaluation like existing data of local authorities – were investigated by a comprehensive survey *(WP "User Requirements")*.
Furthermore, the transition of the theoretical and developing stage of the project to the stage of implementation and testing of the evaluation system will be prepared in close cooperation with different local authorities. As kick-off for *WP "Implementation Strategies"* a workshop was held in Maribor, Slovenia in June 2004.
Additionally to this strategic approach, which deals with the development of *marketing strategies* for the evaluation tool, a pilot project phase has just started at the beginning of July. For more than one year, at least six local authorities will test the TUSEC-IP evaluation system in planning procedures on different planning levels and in different contexts *(WP "Application in Pilot Projects")*.

The Survey of User Requirements on Soil Evaluation

In order to ensure that the evaluation system meets the requirements of future users and fits to the legal, administrative, financial and personnel circumstances of local authorities, a *comprehensive questionnaire campaign* was realised.
Markus Tusch and Dr. Clemens Geitner from the Institute of Geography of the University of Innsbruck managed the development of the questionnaire *"Soil Protection in Urban Areas"* which provides 63 questions referring to all different fields of previous activities and current problems in the use of soil as well as to available soil data in the local authorities. The structure of the questionnaire covers the following sections: *general questions, agricultural areas, built-up areas and contaminated land,*

„Um die Belange des Bodenschutzes effektiver in die Raumplanung integrieren zu können, müssen die Anforderungen der Planer und der Stand vorliegender Bodeninformationen erhoben werden."

Markus Tusch, Dr. Clemens Geitner, Prof. Dr. Johann Stötter

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Das Institut für Geographie der Universität Innsbruck legt seit Jahren einen Schwerpunkt auf die Erforschung von Gebirgsregionen. Dabei werden die aktuellen Themen von Global Change und der Mensch-Umweltbeziehung verstärkt berücksichtigt. Die Eigenschaften, Nutzungsformen und Gefährdungen von Böden unterliegen in Gebirgsregionen besonderen Bedingungen. Diesbezüglich besteht unvermindert Forschungs- und Entwicklungsbedarf.
Im Rahmen des Projektes TUSEC-IP bot sich für das Institut für Geographie die Möglichkeit, eine umfangreiche Umfrage zum aktuellen Stand des Bodenschutzes im Siedlungsbereich des Alpenraums durchzuführen. Es galt nicht nur, die generelle Akzeptanz des Bodenschutzes und vorhandene Erfahrungen bei seiner Umsetzung in Planungsprozessen zu eruieren, sondern auch die vorhandene Datenlage zu Bodeninformationen differenziert zu erfassen. Die zu entwickelnden Strategien im Rahmen von TUSEC-IP können nur dann erfolgreich werden, wenn sie der Datenlage und dem vorhandenen Know-how der Anwender Rechnung tragen.
Ein bedeutender Beitrag der Geographie liegt u.a. darin, vorhandene Bodeninformationen mittels Geographischen Informationssystemen (GIS) so zusammen zu führen und darzustellen, dass sie in Planungsprozessen einfacher und effizienter berücksichtigt werden können. ■

soil protection and land use planning, local agenda 21, available data, user requirements for an evaluation tool, statistical specifications and an appendix including question on soil consciousness. The topic of soil erosion – focus of this issue of local land & soil news – is also covered by the questionnaire.
Questionnaires in four different languages were sent to over 800 local authorities in Italy, Slovenia, Germany, Austria and Switzerland in spring 2004. With an average response of 25 %, the project has gained a wide data base for its further work. After some statistical preparation, the analysis and interpretation of the results started in the middle of June. Various fields of interest were identified for example: the status quo of the role of soil issues in spatial planning procedures, the demand for consideration of soil issues, the importance of specific soil functions and performances, the threats to soils (like wind and water erosion) and the soil consciousness of local authorities.
The results of the data analysis and interpretation will be used as valuable input for the further development of the evaluation tool, for the preparation of the application phase, for the implementation strategies and, last but not least, as important starting point for targeted promotion and dissemination activities.

Soil Issues in Planning Practice

As the analysis and interpretation is in full progress at the current stage of the project, already a first insight into existing soil protection activities and points of view of local authorities in the alpine space is gained. The importance of the protection of soil as resource – like water and air – is generally esteemed to a high extent. According to the information given by the local authorities, land consumption resp. surface sealing is the most significant threat to soil.
However, the opportunities to implement soil protection measures integrated in land use planning procedures are seen critically due to the prevailing circumstances and existing obstacles in planning practice. Especially the lack of legal regulations as well as conflicts of interests and competences are pointed out by the local authorities as major difficulties to enhance the consideration of the soil protection in land use planning.
In order to meet the future users' requirements for the soil evaluation system, which is developed through TUSEC-IP, local authorities were asked which soil related data should be taken into account within land use planning decisions. The answers revealed that soil's capacity in the water cycle (leaching and ponding capacity, flood protection), the ground water level, the present level of soil pollution as well as the soil's function as a habitat for natural vegetation ("biotope potential") rank among the most important aspects. The next issue of local land & soil news will provide an article by Markus Tusch on the user requirements on soil evaluation offering a deeper insight into the comprehensive results of the TUSEC-IP survey.

Important Next Steps

The analysis and interpretation of results of the questionnaire survey, also including specific and comparative analyses of national data, will be finished in August. The results will be used to "refine" the evaluation technique according to detected needs of future users. The evaluation technique was put into practice for the first time within a so-called pretest phase running in July. The following pilot projects reflect an intensive testing of the evaluation technique. Parallel, strategies for the implementation of the evaluation technique will be developed. ■

by Eva C. Lupprian (blue! advancing european projects) for the City of Munich, Department for Health and Environment

About the TUSEC-IP Newsletter

The TUSEC-IP newsletter was introduced in the last issue no.9 of local land & soil news. Now it will be a regular column of llsn informing about the EU-funded INTERREG III B project TUSEC-IP. Whereas no.1 of the newsletter offered a general overview on the project's structure and contents, this issue focuses on the progress of work and specific interim results of TUSEC-IP especially in the fields of user requirements on soil evaluation and the development of the evaluation tool itself. Please notice that all issues of the TUSEC-IP newsletter are available on www.tusec-ip.org.

TUSEC-IP Calendar

On 13-14 September 2004, the annual meeting of all TUSEC-IP partners will take place in Stuttgart-Hohenheim, Germany. This meeting will be used for an intensive exchange with experts on soil evaluation and the legal framework.
Additionally, a workshop on the implementation and application of the evaluation system will be held in Linz on 20-21 September 2004.

Website Updates

Visit www.tusec-ip.org - the comprehensive and appealing website of the project with a broad offer of information and downloads.

Your TUSEC-IP

Would you like to contribute any of your experiences with soil evaluation to TUSEC-IP? Is your local authority thinking about introducing a soil evaluation system? Would you appreciate a specialist exchange of information? Or, would you like to take part in the annual workshop in Stuttgart-Hohenheim in order to get to know more about the project and the current discussion on soil evaluation? If the answer to one of these questions is "yes", please do not hesitate to contact the Lead Partner project team in Munich.

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Gaining Ground – International Conference on Land Use Management and Sustainable Use of Soils

CONFERENCE PROCEEDINGS ARE NOW IN THE INTERNET

Bavarian State Ministry for Environment, Health and Consumer Protection jointly organized a conference with the Protestant Academy Tutzing on land use management and sustainable use of soils. This conference took place at the Evangelische Akademie Tutzing at the Lake of Starnberg, close to Munich April 25 to 27, 2004. The conference proceedings are now on the internet: http://www.stmugv.bayern.de/de/boden/flaech/flv1.htm
Texts are either in German or in English. Further information by thomas.suttner@stmugv.bayern.de or held@ev-akademie-tutzing.de ■

Für jede neue Straße eine alte abreissen

Im Freistaat Sachsen (D) sollen in Zukunft weniger Flächen mit neuen Straßen versiegelt werden. In der *„Sächsischen Zeitung"* vom 28. Juni 2004 betonte der sächsische Umweltminister: *„Um die Bodenversiegelung in Sachsen zu stoppen, sollen auch Straßen abgerissen werden. Bedarf gebe es nur noch an neuen überregionalen Verbindungen. In allen anderen Fällen sollte künftig für jede neue Straße auch eine abgebaut werden. Kommunen und Kreise sollten dazu „Pools" entbehrlicher Straßen erstellen. Ein Vorbild besteht bereits mit der „Entsiegelungsbörse" in der Sächsischen Schweiz und im Weißerritz-Kreis. Es gelte, den Straßenbau ebenso wie die Ausweisung neuer Wohn- und Gewerbeareale zu bremsen."* Mit einer Inanspruchnahme von 8 Hektar pro Tag gehört Sachsen heute zu jenen Bundesländern in Deutschland mit dem größten spezifischen Flächenverbrauch. ■

ELSA contact / order information

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agenda

04.-12.09.2004: Freiburg i.Br., Germany
EUROSOIL – International Congress 2004.
The International Congress which was realised for the first time in Reading, UK in 2000 will take place again 2004 in Freiburg, Germany. Soil scientists and practitioners from all over Europe will consider the part played by soils in terrestrial ecosystems. Actual research results will be presented and discussed in different symposia over a five day period between 6 and 10 September. Some of the main topics are: *Soil as Living Space, Soil Monitoring, Soil use and management, The role of soils in sustaining society and the environment, Regionalisation of Soil Data, Remediation of Polluted Soils, Soil Erosion, Urban Soils and Land Resources*, and over some 15 more subjects. The other days will be offered for Excursions into the French, Swiss and German surroundings of Freiburg.
This congress, which is sponsered by the German Soil Science Society, and others is organized by the Institute of Soil Science and Forest Nutrition of the University of Freiburg i.Br.
More details and information on:
www.bodenkunde.uni-freiburg.de/eurosoil/

18.-22.01.2005: Messegelände in München
acqua alta 05 – Int. Fachmesse und Kongress für Klimafolgen und Katastrophenschutz.
acqua alta vereint alle Bereiche rund um Klimafolgen und Hochwasserschutz auf einem einzigen Event. Folgende Themen werden behandelt: *Klima, Hochwasserschutz, Katastrophenmanagement, Fluss- und Deichbau, Versicherungen, Lawinen, Muren, Glaziologie, Wassermanagement, Dürre, Brandbekämpfung, Sturmschäden, Waldaufforstung, Küstenschutz, Alpine Naturgefahren.* Die Anlass richtet sich u.a. an Kommunen, Europäische Institutionen, Bundes- und Landesministerien, Forschungsinstitute, Umwelt- und Fachverbände, Flusskommissionen, Bergwachten, Lawinen-, Küstenschutz sowie an Fachleute der Planung, des Bauwesens, der Land- und Forstwirtschaft, des Wasserbaus. Weitere Informationen unter www.acqua-alta.de

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