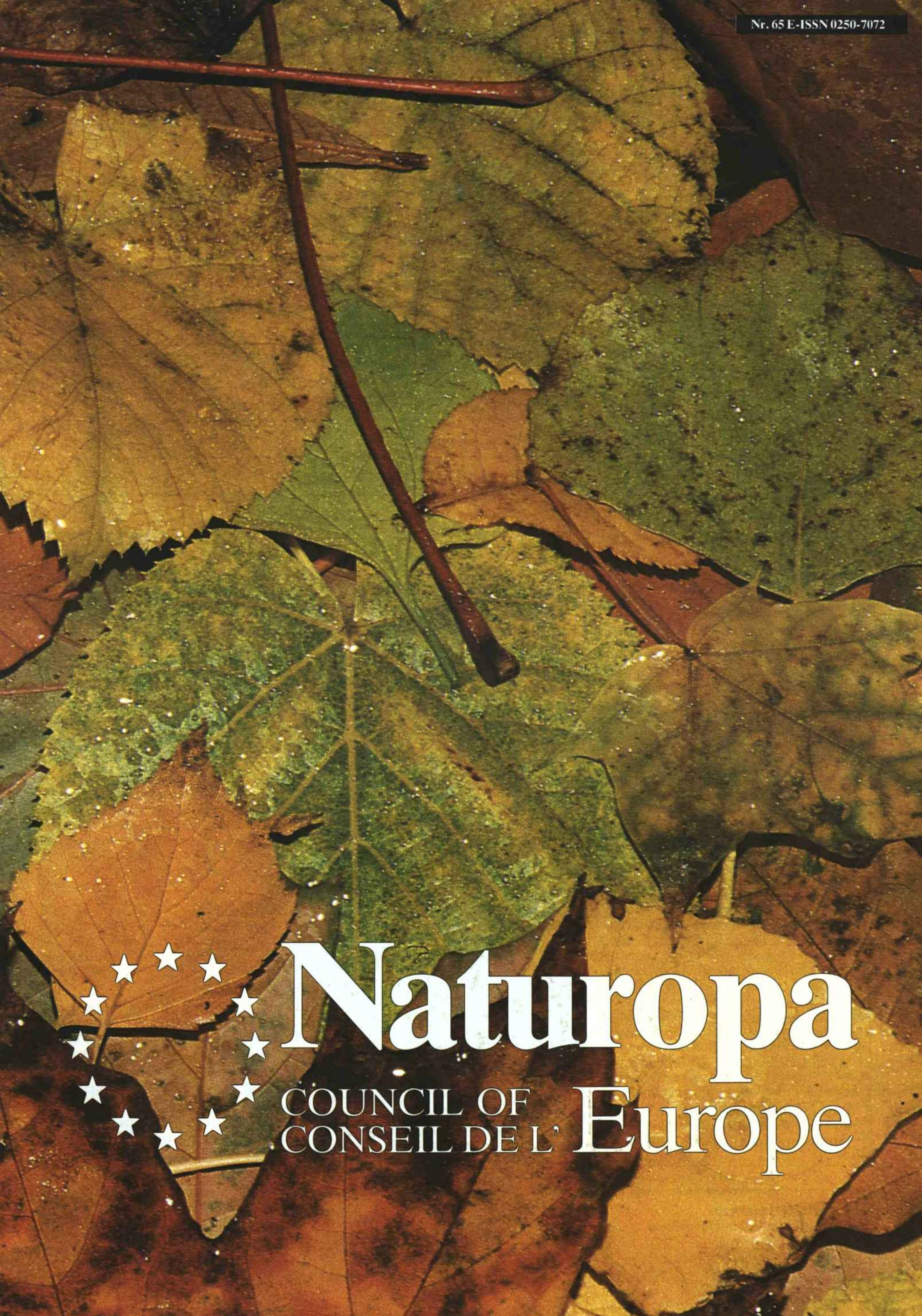

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Naturopa

No. 65–1990

Basic element

By promulgating its European Soil Charter, in 1972, the Council of Europe demonstrated its concern at the future of one of our basic natural resources. Like air and water, soil had previously been considered a necessary, indeed fundamental, element whose availability could always be taken for granted. What a misconception!

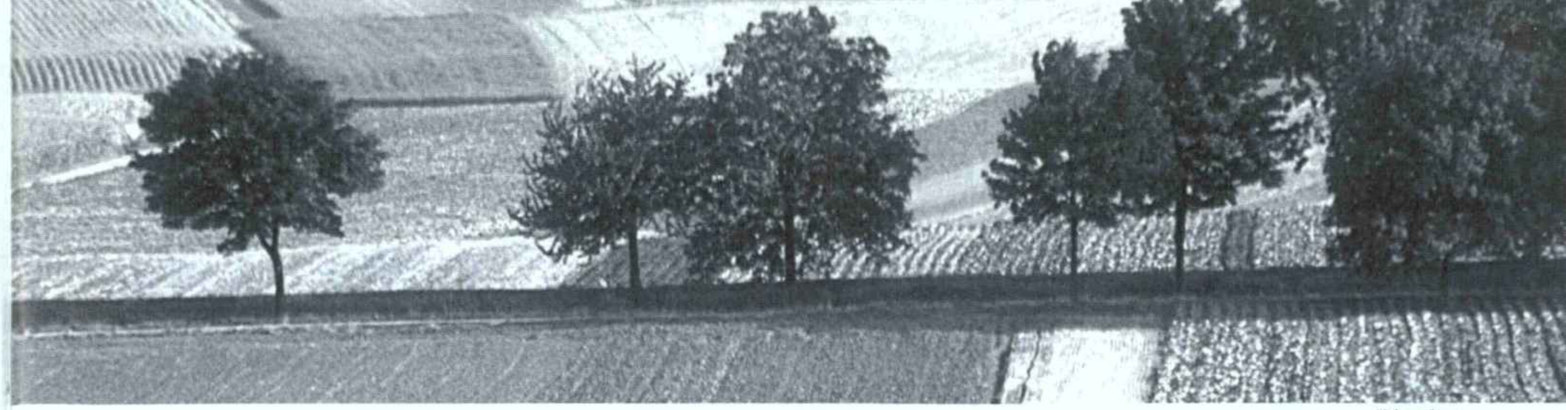
The truth is that, although apparently infinite, soil has limits that are often discovered all too late. Take for example, the sediment to be found in drinking water. Its presence is a sign that the soil has been unable, or has not had sufficient time, to purify the water that seeps down to underground aquifers. Good-quality soil is essential not only to plants which grow in it, but also to animals and human beings which depend on plants for their food. Now that we have realised the value of soil and the scale of the dangers threatening it, we should take action to restore its regenerative capacity in the same way as for air and water.

In October a ministerial conference was held in Brussels for the purpose of studying soil protection in both qualitative and quantitative terms. The results of the conference are expected to prove significant.

In this issue of Naturopa soil problems are "earth-science conservation", a new approach which studies soil in its four dimensions: length, width, depth and time.

Naturopa 66, which will be appearing in spring 1991, will be concerned with freshwater fish and their biotope, providing an important accompaniment to the Naturopa Centre's campaign on the subject. ■

H. H. H.



Friess-Irrmann

Editorial

Nearly thirty years ago the Council of Europe became the first European intergovernmental organisation to take an interest in environment issues. It is now using its experience in the service of one of the major enivronment problems facing our society: soil protection.

The soil is the foundation of all life on earth, the very basis of our food production, the ground on which all human facilities are built and a key factor in the functioning of the earth's ecosystems, and conflicts between its manifold functions and uses are inevitable. As it becomes increasingly polluted by heavy metals, phytosanitary products and discharges, threatened by concrete and growing urbanisation, and impaired by overuse and inappropriate methods of cultivation, its vital production and filtering functions are becoming the subject of increasing concern. The soil, and the water it contains, must be managed from the twin viewpoints of quality and quantity.

As early as 1972, the Committee of Ministers of the Council of Europe adopted a Soil Charter setting out the basic principles for rational use of the valuable natural resource.

At the fifth Ministerial Conference on the Environment in Lisbon in June 1987, the Ministers unanimously requested the Council of Europe "to study the possibility of drawing up an appropriate draft convention on soil protection". A feasibility study was accordingly carried out on national and/or international measures to protect soil and underground water.

This study defines the concept and functions of the soil, gives a general description of the causes of natural or man-induced deterioration and reviews the various protection instruments and measures which exist at national and international level. It shows clearly that an international instrument taking systematic account of all aspects of soil conservation is sadly lacking. There are four ways of remedying this situation:

- *revising and updating the European Soil Charter;*
- *drawing up a specific Council of Europe work programme on soil protection;*
- *preparing a recommendation to member governments on the introduction of consistent soil protection policies;*
- *drawing up a European convention on soil protection to give an international framework to co-operation. The convention could be supplemented by protocols as and when required by changes in the principal soil protection problems and technical and scientific progress.*

Belgium is delighted to have hosted in Brussels in October 1990 the European Ministerial Conference on the Environment at which this question was discussed. The Ministers considered the feasibility study and opted for what they regarded as the most appropriate instrument for co-operation in soil protection.

At the conference, the Ministers also considered the text of a European Conservation Strategy, a declaration whose purpose is to enable governments to back an integrated environment protection policy and to establish an overall framework for future Council of Europe work in this field. Protection of the key constituents of Earth's ecosystems, namely Air, Water and Soil, is naturally a part of the strategy, which also covers, for example, the protection of biodiversity and the problems raised by development, transport and recreational policies and genetic engineering.

The Brussels Conference also gave the Ministers the opportunity to discuss the achievements of the Convention on the Conservation on European Wildlife and Natural Habitats (Berne Convention), which has to date been ratified by 21 member states, Senegal, Burkina Faso and the EEC and is being viewed with increasing interest by Central European Countries. There can be no doubt that the importance of its work makes the Brussels Conference a milestone in the assertion of the determination of all European countries to co-operate in order to shape a Europe in which the quality of life and respect of democracy remain fundamental values, those which the Council of Europe has constantly defended. ■

Miet Smet
State Secretary for the Environment and Social Emancipation of Belgium.

European Soil Charter

1. Soil is one of humanity's most precious assets. It allows plants, animals and man to live on the earth's surface.
2. Soil is a limited resource which is easily destroyed.
3. Industrial society uses land for agriculture as well as for industrial and other purposes. A regional planning policy must be conceived in terms of the properties of the soil and the needs of today's and tomorrow's society.
4. Farmers and foresters must apply methods that preserve the quality of the soil.
5. Soil must be protected against erosion.
6. Soil must be protected against pollution.
7. Urban development must be planned so that it causes as little damage as possible to adjoining areas.
8. In civil engineering projects, the effects on adjacent land must be assessed during planning, so that adequate protective measures can be reckoned in the cost.
9. An inventory of soil resources is indispensable.
10. Further research and interdisciplinary collaboration are required to ensure wise use and conservation of the soil.
11. Soil conservation must be taught at all levels and be kept to an ever-increasing extent in the public eye.
12. Governments and those in authority must purposefully plan and administer soil resources.

Quality as well as quantity

Hector Hacourt

The 12 guiding principles of the European Soil Charter, which all those in positions of responsibility, at whatever level, must endeavour to apply in the sphere of their activities, were adopted by the Committee of Ministers in 1972.

Described in a few strokes, the Charter can be said to cover the notion of soil as a limited resource, its appropriate use by farming, forestry, urban development and construction, methods for its protection (inventory, scientific research, interdisciplinary co-operation, teaching and information) and the responsibility of governments and those in authority.

The European Soil Charter, now 18 years old, is still, unfortunately, a topical issue. It is perhaps even more topical today than in 1972 since environmental problems, particularly those concerning natural resources are now, in 1990, even more acute on account of the dramatic growth of our industrial society.

Forgotten element

Much has been said about air, water and open spaces, but very little about soil. Why is this? Because it is probably difficult to answer the question "What is soil". To the layman, soil is a surface for cultivating, planting, building and digging. In short, the soil we walk on everyday is the base for human activities.

For the experts, the notion of soil is much more complicated since this resource is a very complex medium, continually undergoing both natural and artificial transformations. There are various definitions of soil, which are often related to its functions. Some of these definitions are better than others, but they rarely paint an accurate picture of this both complex and fragile natural resource.

After numerous discussions, a group of experts on soil protection, working in the framework of the Council of Europe's programme of activities, arrived at the following definition:

> "Soil is one of the earth's ecosystems and is situated at the interface between the earth's surface and the bedrock. It is subdivided into successive horizontal layers with specific physical, chemical and biological characteristics. From the standpoint of the history of soil use, and from an ecological and environmental point of view, the concept of soil also embraces deep, porous, sedimentary rocks and other permeable materials, together with their reserves of underground water".

Thus defined, the soil can reach considerable depths and therefore includes, in some contexts, the concept of land.

On the basis of this definition, six basic soil functions can be identified:

- biomass production;
- filtering, buffering and transforming action;
- biological habitat and gene reserve;
- physical medium;
- source of raw materials;
- cultural heritage.

Until recently, the soil could be regarded as a relatively balanced medium, requiring little in the way of external energy forms and raw materials.

Changes

The last few decades have witnessed the arrival of the consumer society, which has created greater demand for land for human settlements and infrastructure and greater demand for food, which in turn has necessitated higher agricultural yields; hence the wider use of fertilisers and plant treatment substances. These rapid changes have interfered with the soil's physical, chemical and biological properties, consequently placing a great strain on its capacity to fulfil its functions, causing irreversible damage in some cases.

All this has led to soil being regarded not simply from the standpoint of the protection of its properties (qualitative protection), but also from the angle of its use (quantitative protection). This approach is reflected in the resolutions adopted at the 1987 Lisbon meeting of the European Ministerial Conference on the Environment and the 1988 Lausanne meeting of the European Conference of Ministers responsible for Regional Planning. It is also the approach behind the Council of Europe's programme of activities in the field of spatial planning, which we will return to later.

As a central element of all ecological interrelations, the soil is a vital resource. Furthermore, it is an easily identifiable asset and has an accepted legal status, unlike other natural resources. However, it should be noted that until recent years, legally speaking, soil was the poor relation since it was not regarded as an essential element of the environment. The only exception to this rule was when soil was regarded as a physical medium for public or private property (urban development, spatial planning and so on). There are several reasons for this situation:

- the complexity of the problem: it is difficult to pinpoint in legal terms all the factors involved;
- the dangers that threaten soil are often initially diffuse and become apparent only in the long term, and are not generally spectacular in the way that the natural disasters of recent years have been;
- most people, no doubt through ignorance, have the impression that soil is not a dynamic medium and that it cannot therefore suffer damage from pollution;
- the impression also exists that soil is not, strictly speaking, a natural resource and that it is therefore an endless resource;
- unlike water and air, for which our needs are permanent (we drink every day and we breathe continuously), soil is not considered by individuals to be vital to them.

Sectoral approach

In most countries, soil protection does not feature as such in legislation; it is simply incorporated into legislation on environmental protection in general which is itself very often sectoral. Since the realisation that soil pollution was developing in some areas, exacerbated no doubt by the spread of groundwater pollution by nitrates and phosphates, there has in recent years been a widespread tendency to set the problem of soil degradation apart from general environment policy. Thus some countries have incorporated soil into their environment policy other than indirectly or passively.

Many international organisations, both governmental and non-governmental, are working on soil protection issues. The Council of Europe has not failed in its duty: soil is a priority field in its programme of activities. It should be noted that the Parliamentary Assembly and the Standing Conference of Local and Regional Authorities of Europe have long been working in this field. These two bodies have produced a number of recommendations proposing concrete measures to consider the soil as a natural resource in the same way as air, water and habitats, and to preserve the quality of its physical, chemical and biological properties.

The two Ministerial Conferences mentioned earlier also dealt with soil problems. They addressed resolutions to the Council of Europe requesting the Committee of Ministers, first, to examine the possibility of preparing a draft convention on soil protection and, secondly, to take account of certain principles for a rational land-use policy. Urban development must be better regulated through national, regional and local development plans, promoting land use that is unwasteful and, in principle, reversible.

Other activities undertaken at intergovernmental level have a direct effect on soil protection. As part of its activities, the Commission of the European Communities is asking its member states to reduce the area of farmland in order to try to reduce food stocks. In our opinion, any agricultural land that is set aside should always be reclaimable by agriculture since it is impossible to predict the human population's food requirements in the medium and long term.

Natural landscapes

The Council of Europe is endeavouring to define principles that could be applied in order to recover this set-aside farmland for nature conservation purposes. The aim of the operation is to restore the greatest possible number of natural habitats, which is the principal means of preserving plant and animal wildlife species. This in turn is the only way of guaranteeing the preservation of the genetic heritage, which must remain as diversified as possible. The protection of the traditional rural landscape not only has aesthetic and cultural implications, but also directly influences soil quality. The Council of Europe is working along these lines with the aim of protecting, creating or recreating natural landscapes, including rural landscapes, so as to preserve the European environment's characteristic diversity.

Evidently, this is a huge task and nowhere near completion. It is vital that this indispensable natural resource be protected since it is the base of our agricultural, forestry, tourist, social and economic activities. Fortunately, the real value of the soil is now known. Without good-quality soil capable of fulfilling its functions, mankind will be faced with disaster. Desertification in Africa, and principally the countries of the Sahel, should serve as a warning that must alert us to the urgency of the real issues in our survival. ■

Ing. H. Hacourt
Principal Administrative Officer
Directorate of the Environment and Local Authorities
Council of Europe

Wild tulips in Alsatian vineyards: soil protection

G. Lacoumette

G. Lacoumette

Soil erosion with gullying. During 5 to 6 months of the year topsoils are nearly bare and exposed to the erosive agents

No-till agriculture

Jan De Ploey

Soil conservation is a necessity in the loess areas of north-western Europe just south of the Baltic plain. The loess belt stretches from south-east England, over northern France and central Belgium, into North Rhine-Westfalia and Lower Saxony. It covers about 8–10 million hectares of which several million hectares of arable land are estimated to be affected by unacceptable soil loss rates of the order of tens of tons per hectare per year. This traditional cereals-sugar beet belt corresponds to an open field in a rolling hilly landscape with a relief of the order of 50–100 m. Quaternary entrenchment of valleys has created an erosion potential. Rill erosion is very likely to occur on slopes exceeding 4–5% for hydraulic reasons. Topsoil degradation, including heavy sealing and crusting, and high runoff coefficients often characterise arable layers, with low consistency. A very critical period of the year for soil erosion is April–June when most topsoils are still poorly covered and rainfall is most aggressive.

In some catchments with mean slopes below 4–5% overland flow production still is high and temporary creeks may entrench thalwegs. Therefore, a certain distinction can be made between conservation measures on slopes and thalweg protection.

In the Huldenberg area

Huldenberg is situated between Brussels and Leuven, within the Belgian province of Brabant, which belongs to the central part of the above-mentioned loess belt. The loess mantle there is often very thin, less than one metre, overlying sterile sediments. The first long-term objective of erosion control has to be the preservation of the loess mantle for in some parcels farmers are already ploughing into sands or clays.

Erosion in general cannot be eliminated by simple interventions like contour-tillage, strip cropping or ploughing the land in a rough cloddy condition. Years of field research and discussions with farmers have led to one convergent opinion. Under the hypothesis of crop rotations remaining essentially the same in the near future, efficient erosion control can only result from the application of conservation tillage. The alternative is a thorough restructuring of topsoils to reduce erodibility and increase infiltration rates. The latter solution is technically feasible but is seriously hampered by financial constraints. Even greater are the problems with a strategy towards reforestation or turning land into pastures.

In 1985 the Leuven Laboratory Experimental Geomorphology decided to test the no-till technique starting with winter barley. The practice of no-tillage means that drilling takes place directly into the stubble of the previous crop, which protects the topsoil as a mulch. All no-till experiments since then have been set up in collaboration with local farmers, without preliminary tests on proper experimental plots.

Slopes very between 2% and 20%. On some parcels, rills formed under preceding conventional tillage had to be filled up before direct drilling. Planting of winter barley occurred at the beginning of October and harvesting took place around the beginning of August. The programme of application of herbicides and pesticides was decided by the farmers and was identical to the one on conventionally tilled parcels. Hitherto no specific weeds or diseases apeared but evidently the test period is much too short to expect any significant evolution. Information on details of the operation can be obtained in Leuven.

The no-till planter used in 1987 is a second prototype built in collaboration with a local factory. Seed is planted at a depth of 2–3 cm in furrows opened in the stubble of the previous harvest by a chisel-type unit. The sowing-pipes are very close to the furrow openers and seeds are injected under slight air pressure so as to have maximum efficiency of no-till sowing.

As expected, rill erosion is completely eliminated on the no-till parcels. During heavy rainstorms, runoff coefficients are still high but load concentrations are very low.

The specifications of the no-till campaign can be summarised as follows:

- 1985–86: 1 farmer, 1 parcel of 1.4 ha, winter barley
- 1986–87: 3 farmers, 3 parcels totalling 2.6 ha, winter barley
- 1987–88: 5 farmers, 6 parcels totalling 8.2 ha, winter barley and 1 parcel with winter wheat
- 1988–89: 4 farmers, 4 parcels totalling 4.2 ha, winter barley

Yields of winter barley (5.6 to 7.2 tons/ha, but 1987 was a wet year) were equal or superior to the mean values obtained in the farmsteads. Farmers manifestly appreciate the effect of evident reduction of soil erosion and also a certain saving of labour, energy and time.

The no-till experiments have promoted, as a spin-off, fundamental research on the differential effects of compaction and mulching on soil erosion. ■

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A. Labhardt

Divergent interests

Marius Baschung

The following thoughts are based on the situation which may be observed in Switzerland. It is a country of some 41,000 km², of which 67.4% consists of mountains, rocks, ice and snow, lakes, forests, alpine pastures and low-yield grasslands. Human settlements – including in particular housing, premises used for professional purposes, means of transport and public services – and areas used for supplies or relaxation and leisure activities take up the remaining 13,500 km². The population lives largely in these areas. 90% of the inhabitants live at an altitude of 800 metres or more and occupy 18% of the country's surface area. This makes the population density equal to about 780 inhabitants per km².

A decisive element in the way land use is organised is the principle, laid down in the Federal Constitution, which recommends "judicious and rational land use".

The regulation of land use, which is one of the main objectives of regional planning, is supposed to guarantee an economical approach to it. In any case, that is how the constituional provision is interpreted in Article 1, paragraph 1, of the Law of 22 June 1979 on regional planning. Hence it is the responsibility of the Federal State, cantons and the municipalities to harmonise their activities and implement a settlement policy which follows national guidelines. To achieve this, public activities must be co-ordinated according to the amount of space available and, above all, balanced land use must be encouraged according to the various needs – not only public, but also, to a much greater extent, private. No matter where this situation arises, the Federal State, cantons and municipalities must be mindful of the facts concerning the natural environment as well as of the needs of the population and the economy. The law expressly states that in the regulation of land use – one need only think of municipal town planning schemes – the different interests at stake must always be carefully balanced: that is regional planning's primary or, one might say, ethical function. Whence the obligation to guarantee a plurality of uses – for housing, professional activities, agriculture, leisure activities etc. Particular care must be taken in this context to protect, as far as possible, all interests, including those which have no lobby to defend them. Moreover, regional planning, which has always been a powerful means of protecting the environment, must more than ever contribute to preserving the ecological balance at municipal, regional and national level.

Absence of consensus

Can ideas like these on regional planning, which clearly have their origins in the Constitution and the law, ultimately be put into practice? It is not easy to answer this question since there is no general consensus on what action should be taken in the field of regional planning. Differences of opinion arise as soon as one starts to interpret the objective expressed in Article 22 (d) of the Constitution: "judicious and rational land use". People more or less agree today that it is necessary to combat the dispersal of housing. Similarly, more and more people acknowledge that we should be unwasteful in the way we use the land. But in the end what actions should we take in order to be able to pursue and realise objectives which have been formulated in such a general way? This question is and will certainly remain highly controversial, not only because of the great differences of opinion between "fundamentalists" and "realists", nor merely because of the belief that the different interests regulate themselves automatically, an illusion maintained for nostalgic reasons which never ceases to interfere with the debate, but quite simply because the factors with which regional planning is daily confronted are constantly changing. Here I am thinking in particular about the needs of the population and of the economy, which are referred to expressly in Article 1, paragraph 1 of the law on regional planning. Added to this are the specific challenges which, in a way, are inherent in regional planning. Here are a few remarks on this subject:

- One is almost constantly witnessing conflicts of interest in matters concerning the regulation of land use. Swiss law stipulates that this regulation – usually at municipal level – must be based on democratic decision-making. But majority decisions cannot replace the preservation of diversity in land use, which is of paramount importance. The balancing of interests is one thing, a majority decision is another. To carry out the task laid down in the Constitution also involves protecting interests which do not have the support of the majority.
- Furthermore, the constitutional principle requiring a balance of interests to be achieved within a framework of varied land use, and with due regard to environmental concerns, is a principle that is not fully realisable. In fact, anyone who has secured certain advantages in the debate over the balance of interests is not obliged to give anything in return. Where land use is concerned, regulations introduced under the law on regional planning lay down rights but not obligations. The lucky landowner in a residential area can quite simply delay his decision on whether he intends to comply with the community's development strategy or not. This attitude is not disadvantageous to him, or if it is a disadvantage, then it is considerably outweighed by the advantages. If he complies with the community's wishes and, for example, agrees to construction work going ahead on his land in order to ensure a sufficient supply of housing, thus abandoning the idea of "hoarding" the land in question, it is not certain that he will continue to hold the same views as a citizen.
- Thus it is not surprising that, from time to time, planning which is in keeping with the Constitution and the law, and which has been decided upon democratically has to give way to behaviour which is motivated by individual interests. In other words, a balance of interests can only be achieved in the regional planning field if citizens are made clearly aware of the need to set aside a minimum area for a particular use. The efforts which we have made hitherto to ensure that information is supplied, as it should be, before any decision is made, are woefully inadequate compared with the responsibility we expect of the citizen in decisions concerning the kind of balance there should be between different interests.

Are we then to conclude that, because of all these difficulties, regional planning is not a valid means of balancing the different interests involved in varied land use? Are the expenditure and effort not justified? Will we be forced to resort to solutions that encroach more and more upon landowners' rights, and solutions that leave no room for the participation of the public? Faced with these questions and many others, there is however one thing which we ought not to forget: there will never be a universal answer, valid for all time, which could be applied to the process of regional planning. This process involves a permanent interplay of political, economic, cultural and ecological factors. Regional planning is a political responsibility which has to be shouldered since, in my opinion, there is no other solution. ■

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"Conflict of interests"

K. Amann

Space and time

A new approach

George P. Black
Gerard Gonggrijp

The Earth, as a planet, was born some 4,600 million years ago. Since its birth, it has been repeatedly altered through the interplay of a wide range of natural processes and the landscapes we see today are just the latest and transient expression of their ceaseless operation. When sometime early in Earth's history, Life began, it took advantage of the environments it found and, in doing so, made its own contribution to the Earth-moulding processes. Today is no different from any other day in Earth's long history, for the physical processes still continue and Life in all its forms still exploits their products.

The task set for the Earth scientist is the study of the Earth in space and in time. First, it is necessary to determine the planet's present constitution and then, with this as a starting point, its history can be unravelled through an understanding of the processes responsible. In this quest, the Present is the key to the Past, so that Earth scientists must spend much time and effort in gaining a full understanding of all currently active natural processes before the work of interpretation can begin. Some processes operate inside the Earth and work on its crust from below. In the short term, they make their existence known from time to time through phenomena such as earthquakes and volcanic eruptions; in the long term, however, their cumulative effects are even more dramatic. The movement of the Earth's fluid interior has split and reunited the continents through geological time—the process originally termed Continental Drift, but now, fashionably, retitled Plate Tectonics—and in doing so has raised great chains of mountains such as the Alps and the Himalayas. Meanwhile, heat generated within the Earth has led to the volcanic activity which built Iceland and most other oceanic islands.

On the surface, change is continual, all landscapes being modified by the action of water, wind and ice. The effects of these external processes are more obvious and therefore more familiar. In the mountains, rivers cut deep valleys, breaking up the rock and removing it downstream to be deposited as sediments where they meet the sea. Rain washes soil into the rivers or, where conditions are suitable, will percolate into the ground to reappear at a distance as springs. Where vegetation is sparse or absent, loose material is swept away by the wind to be deposited elsewhere. In cold conditions, where snow falls and accumulates, glaciers are formed and, near their source, gouge away the rocks to form fiords and lakes. The material removed is later deposited at or near the ice margins where it is frequently reworked by water from the melting ice. The sea plays a varied role—in places it acts as a potent agent of erosion, wearing away the cliffs and beaches along its margin, but elsewhere it is a passive recipient of the sediment supplied by rivers, glaciers and wind transport.

Finally, there are extra-terrestrial agencies which affect the Earth. The significance of some of these is still a matter of debate, but there can be no argument that the Earth continues to receive material—in the shape of shooting stars and meteorites—from Space and some would argue that some significant events in our history, such as the extinction of the dinosaurs, are to be attributed to extra-terrestrial causes.

The impact of man

The arrival of Man has changed the balance between the various natural, Earth shaping forces. At first his impact was small but it has grown steadily with time until in recent years it has become a factor of considerable potency.

Over vast areas, in a few thousands of years, Man has replaced much of the natural vegetation by cultivated plants. In some particularly vulnerable areas, this has favoured the process of denudation and erosion, causing an expansion of some types of landscape such as the badlands of the Mediterranean countries. As farming methods have become more intensive, they have increasingly demanded the removal of small-scale landforms and have destroyed, through deep ploughing, soil profiles which have developed over hundreds, or thousands, of years. Drainage has led to the lowering of ground-water levels, and this can cause a serious loss of geological data relating to the recent past, especially where this has been preserved in the anaerobic conditions associated with organic sediments such as peat.

Measures taken to regulate rivers interfere with the naturalness of stream systems. This process is most advanced in the Netherlands where almost all river and brook systems have been embanked and regulated to a greater or a lesser extent. Although canals are effective and not without beauty, they lack the appeal—and the scientific interest—of the meandering rivers they replace!

Along much of the coast, projects designed to prevent marine erosion have had a marked effect through preventing the operation of the natural processes of marine erosion and deposition and, in particular, through preventing rock exposures being naturally maintained by the sea. Likewise, the stabilisation of coastal and inland dune systems brings to an abrupt end the operation of natural processes.

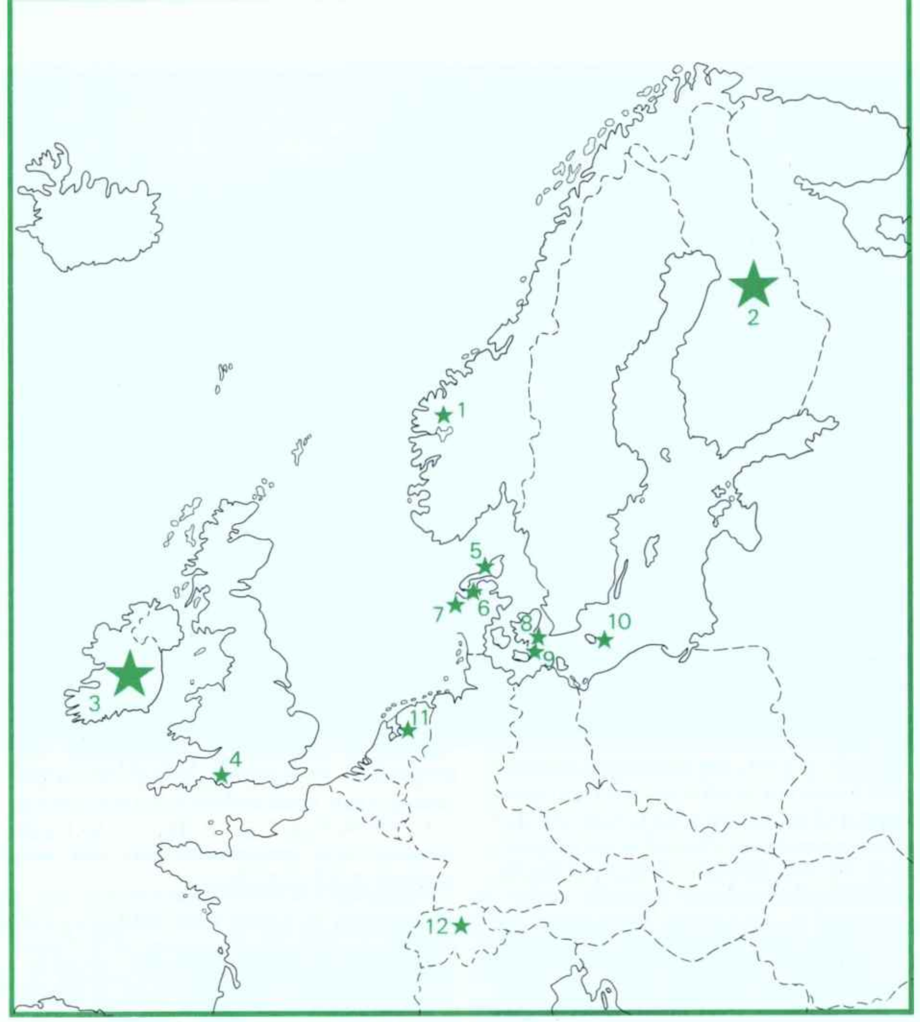
The extraction of minerals such as clay, sand, gravel, peat and chalk exposes the outer layers of the Earth's crust, most frequently where no such exposures existed before. To this extent, mineral extraction is beneficial to the Earth sciences. In the past, most mineral excavations were widely scattered and on a small scale and, until recently, except in areas of peat working, they did not greatly influence morphology. However, as minerals have become progressively easier to transport, so mineral extraction has tended to become concentrated in those small areas where it is particularly profitable. As a result, mineral excavations have become much fewer in number while each has become much larger in size. The reduction in their number and the increasing localisation of their distribution have reduced the benefits they yield to Earth science whereas the growth in size of individual workings has greatly increased their impact on geomorphological features, even those on quite a large scale.

In most cases, the creation of exposures showing the internal structure and composition of landforms through mineral extraction is only small compensation for the eventual destruction of the landform itself. Furthermore, such exposures, even where they display geological and pedological phenomena of great interest, tend to be only temporary for, like all exposures, whether natural or artificial, they are liable to become obscured by natural processes or, in case of many disused and neglected pits and quarries, by "restoration" involving infilling and revegetation.

The impact of urbanisation is also unfavourable in that it denies access to the strata which lie below the surface and masks, or even destroys, entire landforms.

Human impacts on this wide scale can lead to the partial or total destruction of complete geological sections and geomorphological features and soils. Notorious examples are to be found in large parts of the Salpausselkä moraines in Finland, and in the building of a city quarter upon a unique "fossil" braided river system in the Netherlands. Further losses have occurred in the decline of areas of peat across North-Western Europe, in the expansion of the areas of brown-coal working in Germany and, on a smaller scale, in the loss of a number of the type-sections—the irreplaceable rational and international standards upon which the Earth sciences depend—such as the original type-section for the Tiglian.

In short, the rapid growth of population and of technical development has produced a correspondingly rapid growth in the impacts suffered by the geological landscape which, in many places, has undergone irreversible change. Many geological features were formed many thousands, or millions, of years ago and are, in effect, "fossil" rather than still actively developing—once destroyed, such features are lost for ever. Even in the case of the phenomena associated with the recent Ice Age—phenomena which constitute a very significant proportion of the geological landscape of Europe—there is no prospect that, once destroyed or damaged, they can be replaced or repaired. Even although another Ice Age is only to be expected, it will take a long time before the Scandinavian ice sheet readvances over Russia, Poland, Germany and the Netherlands to make good the damage we do to the landscape produced by its predecessor!



1. *Nigardsbreen (N)*
2. *Eskers (SF)*
3. *Irish peatlands (IRL)*
4. *Dorset (GB)*
5. *Lonstrup Klint (DK)*
6. *Hanklit (DK)*
7. *Bovbjerg (DK)*
8. *Stevn's Klint (DK)*
9. *Mons Klint (DK)*
10. *Bornholm (DK)*
11. *Heetveld (NL)*
12. *Zug (CH)*

The need for earth science conservation

Over the past few decades, the continuing degradation of the geological landscape, through which increasing numbers of both traditional and new study areas have been adversely affected by all kinds of human activities, has increasingly alarmed Earth scientists. One by one, geomorphological features have disappeared partly, or even completely, so that the landscape has changed little by little. Sections in pits, quarries and cuttings, used by geologists for reference, or valued as examples, have vanished through being filled up and grassed over. All these activities are hostile to the primary aim of Earth science conservation, which seeks to secure the retention of all landforms and exposures needed for research, training and education.

There are of course further reasons why Earth science sites should be conserved. For example, untouched, or virtually untouched, areas which retain their original soils and vegetation are very important for studies in ecological development. Even if the vegetation is not original, but has been replaced, areas whose soil remains largely intact can still be of potential value to ecology.

Some would also add ethical considerations. Should we, for instance, everywhere transform the natural geological landscape, formed in the course of thousands, or even millions, of years, into an artificial one? Considerations of this sort supplement the largely objective arguments for conservation based purely on the needs of Earth science—and also those based on ecology—and lead to the more subjective perception of landscape as an amenity. It is only natural for Earth scientists to give priority to their own particular motives for conservation, but they, like the biologists and the experts in landscape amenity, should not forget that conservation can be justified on other grounds.

Selection of sites

Our natural environment can be put to many different uses, of which the provision of information regarding geological processes and their results, is only one. In formulating an overall policy for land-use, all the other potential and competing uses have to be respected and a balance struck—for Earth science conservation, compromises have to be made, especially where the possible alternative uses (e.g. mineral extraction and the conservation of geomorphology) are clearly incompatible. It is therefore necessary to be able to select those features which merit conservation; it is equally necessary to be able to justify this selection through an ability to demonstrate that it has been based on the proper application of a series of rational criteria which have been devised to accord with nature conservation policy.

The criteria used in the selection of important Earth-science sites are more or less the same in most countries and include rarity, present condition, representativity, diversity, and scientific and/or educational importance. In addition, other aspects such as size, clarity, accessibility and vulnerability are seen as important. The possibility of recreating a site is less often of relevance, for it must always be remembered that most Earth-science sites are irreplaceable. After sites have been assessed through the application of the various criteria, they often have to be categorised in some way, for example, into those of international, national, regional, and local significance. In this categorisation, the Earth sciences have a great advantage in that a worldwide system which identifies standard sections of international and national status has already been established for many years.

Earth-science conservation in Europe

At the end of the 19th century, increasing human impacts on the landscape led to the rise of nature conservation movements all over the world; in this movement, biologists took the leading role. Earth scientists, many of whom were involved in the exploitation of natural resources, were, in general, not fired with the same enthusiasm. Moreover, at that time, mineral exploitation was not extensive by present-day standards, was little regulated, and the damaging "restoration" of disused workings was not commonly practised. Nevertheless, individual Earth scientists and members of nature conservation societies gradually became more and more involved in Earth-science conservation.

Ice-carried erratic blocks were an early feature to impress and challenge Earth scientists and it is no surprise that such blocks were among the earliest features to receive protection. In 1867 the Geological Commission of the Swiss Nature Research Society (Geologische Kommission der Schweizerischen Naturforschenden Gesellschaft) proposed to protect erratic blocks and, shortly after, the Swiss State bought the most important. At about the same time, the City of Edinburgh protected the famous "Agassiz Rock" on Blackford Hill, a striated rock face where, in 1840, the Swiss geologist, Agassiz, had recognised evidence for the former existence of glaciers in Scotland.

Voluntary conservation societies often had great influence on the policy of governments. The first Dutch nature conservation society was established in 1905, and recognised the importance of Earth science conservation; not long afterwards, in 1907, the State established its first nature reserves, among which was an inland dune area showing active aeolian processes.

In 1909, the Norwegian Geographical Society recommended that provisions for the protections of scientifically and historically important geological and mineralogical sites should be included in the first Norwegian Nature Conservation Act; this Act became law in 1910, and was one of the first of its kind in Europe. In 1905, at a meeting of the Geological Society of Stockholm, De Geer drew attention to the need for the conservation of natural monuments. This led to the preparation of the first official inventory of Earth-science sites in Sweden.

These examples of the early initiatives in the development of the Earth-science conservation movement in Europe were promising, but in practice it took many years before Earth-science conservation could obtain a standing equal to that of biological and archaeological conservation. Meanwhile, despite good official intentions, it was mostly individual action which led to the protection of sites and, although in some countries small-scale site inventories were prepared, such initiatives did not result in the adoption of effective national policies for Earth-science conservation.

In 1949, the British Parliament passed the National Parks and Access to the Countryside Act which defined the conservation policy of Great Britain for more than 30 years. This Act recognised Earth science conservation as an equal partner with biological conservation and, when shortly thereafter the Nature Conservancy (now the Nature Conservancy Council) was established as the national official conservation body, its structure made provision for a separate Geology Section responsible for the conservation of Earth-science sites, then a unique event in Earth-science conservation in Europe. The Section and its successors prepared many inventories and carried out a wide range of other projects but it soon became apparent that being recognised as an equal did not necessarily mean being treated as an equal—the Earth sciences consistently received much less than their fair share of the available resources.

Belated awareness

In most European countries, the adoption of a more active policy for Earth-science conservation dates from somewhat later, often from the end of the 1960s and early 1970s, the timing being influenced by a general revival then experienced by the nature conservation movement as a whole.

In Sweden, at a wide-ranging discussion on the protection of eskers, the opinion emerged that the Earth-scientific importance of some eskers well merited special consideration. This led to the acknowledgement of Earth science conservation in the Nature Conservation Act of 1952 and to a number of initiatives being taken. Several projects focused on Earth science conservation were begun in the 1960s and 1970s and these still continue, an example being the Geomorphological Inventory of North Sweden.

In connection with the establishment of the Norwegian Ministry of Environment, the preparation of plans on a county-by-county basis to show areas and sites of conservation value, including those of value to the Earth sciences, was commenced and this programme is still in progress.

Preparation of nation-wide inventories of the eskers of Finland began in 1972. These are prepared to supply a factual basis for decisions in physical planning, such as allocation for gravel extraction, recreational use and conservation. A national inventory of other types of Earth-science site is now in preparation.

The compilation of a National Heritage Inventory in Ireland began in the early seventies and the results were published in 1981. This publication includes Earth-science sites, but such localities are not covered by the Wildlife Act (Nature Conservation Act). Earth science sites have been left to depend for their protection on planning control by the local authorities, a system which, in practice, does not function satisfactorily.

The Dutch working group "Gea" commenced the preparation of a comprehensive inventory on a national scale in 1969 and completed this task in 1988. As a result of these activities, Earth-science conservation was acknowledged in 1982 in a Structural Scheme for Nature and Landscape Conservation. Although this scheme was not directly translated into a concrete conservation policy, it had implications for the future. In the Nature Policy Plan, published in 1989, Earth-science conservation is specified as one of the four conservation objectives and proposals for further projects in Earth-science conservation have recently been formulated.

In 1984, the Ministry of Environment in Denmark published a list of 197 sites of national Earth-scientific interest, as a base for conservation. Further inventories on a county level have also been completed.

The Spanish Geological Survey is currently editing several well-produced guides to Earth-science sites as a basis for conservation and education.

In those countries with a federal structure, the initiatives for the preparation of inventories have mostly been taken at a provincial level.

In Austria, the lead has been taken by Vorarlberg; in co-operation with the University of Amsterdam, an inventory of Earth-science sites is in preparation. In Sankt Gallen in Switzerland, a start has been made in compiling inventories at a municipal level. In the several states of the Federal Republic of Germany, the Geological Surveys and Geological Institutes are active in the same field.

The above short review is far from complete, and data are lacking from many countries. It will serve, however, to give some impression of current activities in the field of Earth-science conservation across Europe.

Black/Gonggrijp

The canyon of the River Verdon (France), a monumental example of fluvial erosion

International co-operation

Until 1988, over most of the field of Earth-science conservation, there were only incidental, bilateral, international contacts, although there had been for some time conservation-oriented discussions at an international level within a number of specialised disciplines.

Inquiries made among Earth-science conservationists by the second author in 1987, revealed that there was a great need for, and desire for, an enhanced level of international contact. Based on the results of these inquiries, a first international workshop was organised in 1988 and met at Leersum in the Netherlands. At this meeting, the 12 participants from Austria, Denmark, Finland, Great Britain, Ireland, Norway and the Netherlands discussed subjects which included legislation; conservation policy; classification, listing and selection of sites; site management and education.

During the meeting, it became clear that, in the participating countries, Earth-science conservation has been treated more or less as a step-child in comparison to biological conservation, although there were legal provisions which made Earth-science conservation possible. There was general confidence that this situation would be improved if an active working group were set up to operate on a national and international level. Great importance was attached to informing national Earth-science organisations and authorities, and international bodies such as the Council of Europe, EEC, IUCN, and Unesco and, of course, the international scientific organisations, about the need for Earth-science conservation. Recognition was also given to the need to enlighten the general public on the role Earth-science plays in so many human activities and to make them more Earth-science minded.

This first meeting led to the establishment of the European Working Group on Earth Science Conservation with the following aims:

- to facilitate the exchange of information
- to provide mutual support in the conservation of threatened sites
- to promote Earth-science conservation
- to identify and execute common projects, i.e. projects of benefit to more than one country.

The first common project was the preparation of an information paper on international Earth-science conservation to be illustrated by examples from the different countries and this appears in this edition of Naturopa.

At the succeeding meeting, held in June 1989 in Bregenz in Austria, it was decided to publish a manual on the practice of Earth-science conservation across Europe. This will be concerned with the relevant legislation, policies and procedures, and will outline the constraints on field studies to be found in the various countries. The work is intended as a first move towards standardisation, and as a stimulus for countries where, as yet, Earth science conservation is not practised.

A third project, the identification of Europe's most important sites, is to commence in the near future. This project, of course, will require the formulation and development of a standard set of criteria against which candidate sites can be judged in a European context. The success of these initiatives depends in large measure on the full support of a wide range of organisations and individuals from all European countries working in the field of Earth sciences, and will also require financial backing.

The papers which follow are designed to give an impression of the various kind of sites and the problems Earth-science conservationists have to deal with in a number of countries. They also show that, although the first steps in European Earth-science conservation have been taken, there is still a long way to go. ■

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The start of Naßfeld Geo-Trail

Geo-Trail

Hans Schönlaub

In Carinthia, the southernmost province of Austria which borders on Italy, the Gail Valley and the surrounding Carnic Alps are known to geologists worldwide as one of the most interesting Earth science sites in Europe. This distinction arises from their being the only place in the Alps where there is a continuous fossiliferous record of the Earth's history—without any breaks—from the Middle Ordovician to the Triassic. As might be expected, since the middle of the 19th century, there have been numerous publications which describe the various fossil groups and rocks in great detail, document the geology on successive revised editions of geological maps, give accounts of newly collected fossils, and update synoptic studies of rock facies and tectonic evolution.

To make people realise

However, most, if not all, of the currently available knowledge has been accessible to, and—what is even more important—has been comprehensible to, only those who were experts in the Earth sciences. With this in mind, proposals were drawn up for a Geo-Trail which would present some of the most exciting geological phenomena of the Carnic Alps of Austria to the interested public, both visitors from abroad and the local population. From its concept, it was intended that the Trail would provide a further attraction for the local tourist programme.

Early in 1985, the Geological Survey received approval for the proposal from the communities involved, from the province, and from the tourist authorities of Carinthia and the Austrian government. The project was completed by the summer of 1988 and since then, has been open to, and much used by the public. By the close of 1989, costs had totalled almost 1.5 Million Austrian Schillings.

The Geo-Trail covers an area of approximately 350 square kilometres and consists of five geological trails, each between 3 and 6 kilometres in length. These can be connected to form a super-trail with a length of more than 100 km at altitudes from 700 to 2200 m. Each trail comprises up to thirteen stops, each marked by a plaque measuring 50 × 40 cms and mounted on a wooden frame. Additional stops, which connect the individual trails are located at interesting geological or palaeontological sites.

The plaques consist of resistant 3 mm thick aluminium plates to which a UV-resistant printed foil is glued; for additional protection this foil has been covered with a layer of resistant hard lacquer. Each plaque gives information about the scenery, the geology, the stratigraphy, fossils, tectonics etc. in non-sophisticated language. At scenic points even larger plaques, 150 × 70 cm in size, are mounted to present additional information which includes the whole panoramic view which, in some places, takes in a great part of the Eastern Alps!

To inform

Special plaques of even larger size are located at the starting point of each Geo-Trail. These inform visitors about the length and other details of the trail, including a sketch and other general information.

In addition to this information available along the trails, small displays of fossils and rocks have been set up in mountain huts and in local museums. A book with 167 pages, summarising all field and additional data, can be purchased for a very moderate price and even stickers, a T-shirt and a badge can be obtained on request. Since the summer of 1990, a booklet which includes all the information about the Geo-Trail in an abstract form, and which briefly characterises each stop, has been available free of charge.

Two years of operation have proved the whole programme to be very successful. Hotel owners and private landlords have started to organise tours for their visitors and guests, while other guided tours are organised by the local tourist offices. Many visitors, however, choose their own programme which can involve strenuous mountaineering or hiking through the Carnic Alps from west to east for a distance of more than 150 kilometres.

Despite the publicity given to the Geo-Trail through TV news, newspaper articles and other PR activities, and despite its popularity, there has been neither exploitation of fossil localities nor any serious damage to the information plaques. The future maintenance of the Trail has been guaranteed by the local communities. ■

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The Nigardsbreen Glacier

Lars Erikstad

"Its colour is sky blue and it is as hard as the hardest stone ever could be with big crevasses and deep hollows and gaps all over and right down to the bottom. Nobody can tell its depth although they have tried to measure it. When at times it pushes forward a great sound is heard, like that of an organ and it pushes in front of it unmeasurable masses of soil, grit and rocks bigger than any house could be, which it then crushes small like sand. In summer there is an awful cold wind blowing off it. The snow which falls on it in winter vanishes in summer but the ice glacier grows bigger and bigger."

This vivid description of an advance of the Nigardsbreen Glacier dates from 1744 and is still an excellent illustration of the importance of glaciers in the Norwegian mountain landscape. Glaciers deserve attention, not only for their aesthetic value and, as described above, for their destructive potential, but also as phenomena of importance to the earth sciences. The opportunities they give to experience and study active glacial processes provide the basis for understanding the processes which operated in the past during ice ages and, in addition, the response of glaciers to present climatic change makes it possible to trace climatic changes in the past. Such studies naturally take into account what historical records exist, but also rely greatly on data derived from glaciofluvial sediments and from glacial deposits such as moraine ridge systems. Since glacial areas are popular with tourists, they have great potential for public education, for the promotion of the Earth science and for the furtherance of Earth science conservation.

European largest icecap

Jostedalsbreen (487 km^2)—the largest icecap on the European mainland—is situated in the western part of South Norway, and is a long and narrow plateau glacier from which numerous valley glaciers flow. Of these, the Nigardsbreen Glacier (48 km^2), on the eastern side of the main plateau, is one of the best-known. This glacier is not a relict from the Ice Age but dates probably from about 2,500 years ago and, like all the other Scandinavian glaciers, grew strongly in the "Little Ice Age" of the 17th and 18th centuries. This advance culminated in 1748 when the glacier reached a position marked today by a large moraine ridge. Since reaching this position, the glacier has shrunk and its snout now lies about 4.5 km behind its 1748 position. Numerous moraine ridges lie in the outer part of the area from which the ice has disappeared and these reflect a relatively slow retreat of the ice front, broken by several halts and small advances, up to the 1930s. Between this moraine landscape and the present end of the glacier, there is almost no morainic cover and most of the valley floor is occupied by a lake. The snout of the glacier now lies a few hundred metres further upstream.

Point of reference

Nigardsbreen is one of the best studied glaciers in Norway and the known history of its advances and retreats has proved of great value as a standard against which the advances and retreats of other glaciers can be compared. Its retreat from the 1748 limits is well-documented for, in the 19th century, the glacier was observed by scientists on several occasions and it was chosen as a subject by a number of artists. In the present century the area has been the subject of intensive research and, over recent decades, the glacier front, the mass balance, and the runoff and sediment transport of the glacier stream have been regularly measured. These studies show that, over this period, the glacier's mass has increased and that the retreat of the ice front has now stopped.

Scenically, the valley, in which the Nigardsbreen Glacier lies, is most spectacular and has long been attractive to tourists; accordingly, a tourist road has been built through the morainic landscape and the moraine ridges nearest to the road have been threatened by gravel extraction. Also, some years ago, Nigardsbreen was threatened on a much wider scale through its being included in a projected hydroelectric development. Since the proposals called for water to be taken from beneath the glacier and diverted to a neighbouring valley, as well as the installation of sediment interceptors and the building of further roads, they posed a grave threat to the status of the glacier and its environs for glaciofluvial reference and research.

Fortunately, during the planning process, Nigardsbreen was excluded from the project and, later, the area was established as a nature reserve. The Norwegian Parliament also decided that those other parts of Jostedalsbreen which were not affected by hydroelectric development should be declared a National Park. In this way, the valley of Nigardsbreen has been secured both for the enjoyment of visitors and for scientific use as an area important for reference and education.

However, the authorities responsible for the management of nature still face a difficult task in establishing a management policy which can reconcile the scientific objectives of the nature reserve and the, often conflicting, demands of the tourist industry. For instance, when plans which had been drawn up for an information centre were shown to tourists visiting the glacier, and their reactions were sought, it was found that a majority thought the buildings proposed were too large and dominating, and would adversely affect the natural character of the valley. ■

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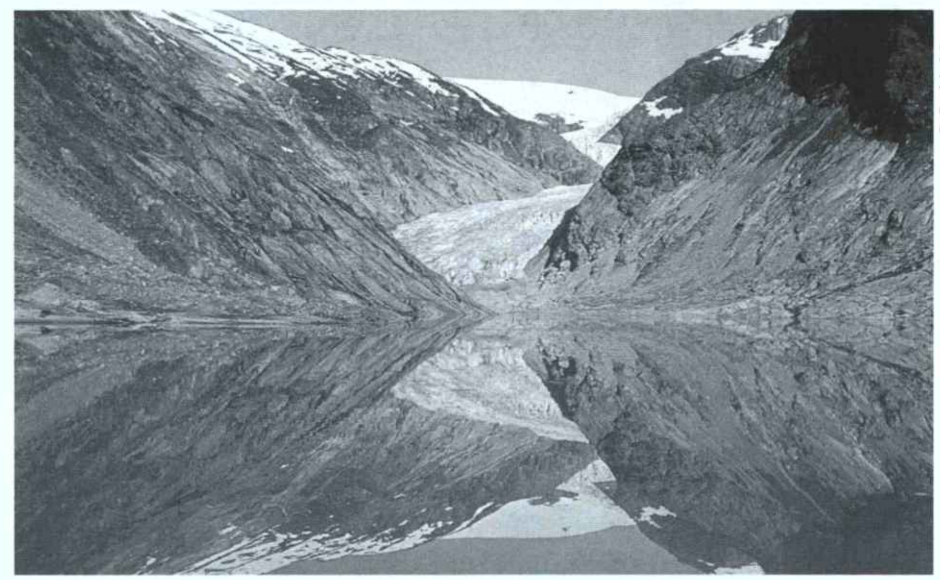
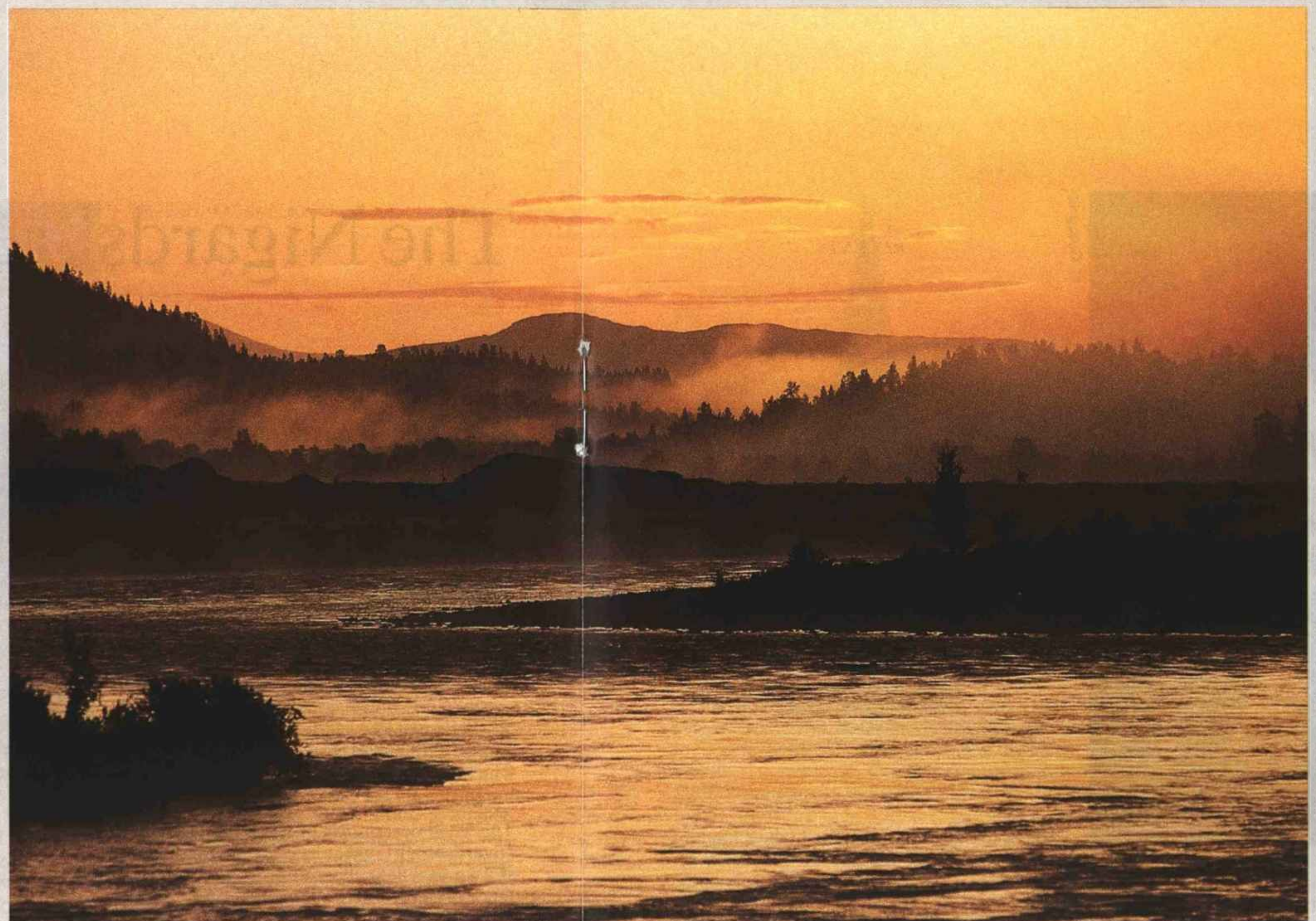


S. Smith-Meyer

The kind of Europe we want



As the end of the century approaches, Europe finds itself facing a number of major challenges, and it is now more vital than ever that we should think about our own future and the kind of Europe we want.

We at the Council of Europe want a Europe based on human rights, pluralist democracy and the rule of law, a Europe based on solidarity, and counting social and economic rights and the right to a healthy environment among its main concerns.

The environment itself is one essential aspect of those basic rights.

Thus, long before the political developments which are now bearing out the aims which we ourselves have pursued for so long, the Council of Europe drew up, in 1979, an international environmental instrument, covering the whole of Europe and open to non-member states: the Convention on the Conservation of European Wildlife and Natural Habitats.

This Convention, which is known as the Bern Convention, embodies a full-scale strategy for the management of natural environments. It lays down general principles to be followed in any activity potentially contributing to the conservation of wildlife habitats.

In accordance with the wishes expressed by the European Environment Ministers at the Conference organised by the Council of Europe last October, I want this Convention to become the central instrument of intergovernmental co-operation on nautre conservation at European level.

Similarly, in the matter of soil, our Organisation introduced the Soil Charter as long ago as 1972. Very recently, in Brussels, the Council of Europe has started looking at the various initiatives needed nationally and internationally for soil conservation, pending the conclusion of a convention on the question.

On 18 and 19 December 1990, the Council of Europe will be hosting a major pan-European conference on the protection of forests in Europe. Specifically, the European Ministers responsible for forest management will be working out a European policy for the conservation of forest genetic resources.

Information is an essential aspect of modern democracy, and our Organisation's Centre Naturopa has been set up and given the resources to provide information in all these fields. Obviously, the review Naturopa will also continue to provide a maximum of information on protection of the environment throughout Europe.

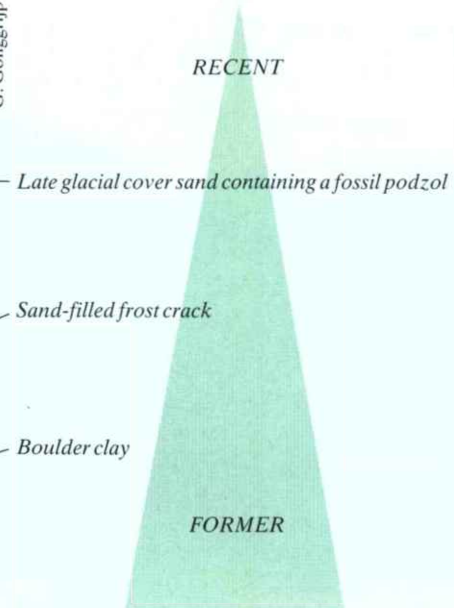
Catherine Lalumière
Secretary General of the Council of Europe

De Zândkoele

Gerard Gonggrijp

In comparison to many other European countries, with their mountains, deep valleys and cliffed coasts, the Netherlands is a country of low relief and, accordingly, with few natural geological exposures. In consequence, the Earth scientists and the interested laymen who want to examine what lies beneath our land surface have to rely very largely on artificial exposures, such as pits and quarries, to satisfy their curiosity.

Their reliance on man-made exposures of this sort, however, is not without problems, for such exposures tend to be short-lived and to disappear through the dumping of rubbish, afforestation or just plain neglect. To prevent the loss of such sites—and the unique information they provide—Earth-science conservationists are succeeding in their efforts to have more and more conserved and maintained in a "geologist-friendly" condition. One of these man-made outcrops lies in Heetveld, a hamlet 20 km north-north-west of Zwolle, the capital of the Province of Overijssel.



Development of the landscape

Heetveld is built on a isolated complex of low hills formed of material pushed up by an ice sheet flowing from Scandinavia; some 150,000 years ago, this ice sheet covered the Netherlands during the glacial period which preceded the most recent Ice Age. At a time when the ice sheet was expanding, its advancing front acted as a bulldozer and, when it encountered some river sediments, which had originally been laid down as horizontal beds, it tilted and deformed these to build the hills. Later, it seems that the ice overrode the hills for they now have a streamlined form as if sculpted by ice movement. Still later, as the glacial period ended, the ice melted and, in doing so, left a deposit of "boulder clay"—the clay, sand, gravel and boulders which it had picked up during its southwards journey.

In the northern part of the Netherlands, there are several occurrences of low hills (up to 20 m in height) which have been formed in this way. Some of these have the ideal egg-shaped streamlined form, known to geologists as a drumlin, which is characteristically found where ice-sheets have moulded the rocks over which they once passed. Ice-pushed features are also found in the central and eastern Netherlands, where they are on a much larger scale, rising to as much as 120 m above sea-level, to form the highest land in the Netherlands, outside the Province of Limburg.

After this ice sheet had melted, the hills it had formed were subjected to the normal process of erosion and, when the climate had recovered to something resembling the present, became covered and stabilised by dense vegetation. The Earth, however, does not stand still and the warm inter-glacial climate was not to last; it was succeeded by the glacial conditions of the most recent Ice Age.

During this later glaciation, the ice sheet did not reach the Netherlands, but the country was nevertheless affected by a return of a cold Arctic climate. In summer, the upper layers of the soil which covered the hills melted and slid down their slopes while, during dry periods, the strong Arctic winds picked up and transported sand from nearby valleys, to deposit it in sheltered areas, either as flat layers (as around Heetveld) or as low dunes up to a few metres in height. These wind-blown sand deposits are known as the "Coversand".

Over the course of time, the meltwater and the strong winds sweeping over the hills took away fine material from the boulder clay leaving the coarser gravel and boulders to form a "desert pavement". As the direction from which the prevailing winds came was constant over long periods, some of the exposed pebbles and stones were facetted by natural sand-blasting. In areas with little snow cover, the ground was exposed to extreme cold and was cracked by the frost; once formed, such cracks were enlarged with each succeeding period of extreme cold.

As the last ice age ended, podzolic soils were formed under a cover of birch and pine during a period of relatively warm conditions. In recent times, as the climate approached its present condition, the hills were denuded of their natural woodland vegetation in the interests of agriculture. On the exhaustion of their rather poor soils, farmers applied fertiliser in the form of a mixture of stable manure and sods. In places this has given rise to rather deep, blackish, humic soils.

Geological monument

In 1981, the author examined a sandpit used as a communal storage yard which had been excavated in one of the glacially moulded hills known as the "High Land of Vollenhove" after a small town lying a short distance to the west. Although the face of the pit was badly exposed, enough could be seen for a geological section representative of the locality to be discerned. This showed the boulder clay formed in the penultimate glaciation overlain by the Coversand formed during the last glaciation; the succession was not very special, but was geldom seen and therefore of high educational value.

When the owners of the site were contacted and informed of its scientific value, it was discovered that they had already agreed to its use for cycle-cross racing. However, the physical properties of boulder clay proved unsuited to the needs of this sport and conservation was given another chance. Even the apparent set-back had its silver lining, for in the preparation of the racing track, fresh faces had been opened to supplement the original exposures!

In a face 2.5 m in height can be seen features representing the last 150,000 years of geological history over a large part of the northern Netherlands. Boulder clay cracked by frost is the oldest deposit, its upper part having been long since removed by erosion. Above this eroded surface lies the Coversand with a desert pavement containing stones facetted by natural sand blasting, the relics of a bleached podzolic soil and a recent podzol partly mixed with a humic soil. All in all, a unique soft rock exposure!

After these features of interest had been demonstrated to the mayor and councillors of the local community, proposals for the management of the pit in the interests of conservation were prepared and were implemented in 1984. To make the site more informative to the general public, an outline map of Scandinavia, measuring 30 m by 30 m, was marked out on the pit floor using small boulders. On this were placed the larger ice-carried boulders found in several parts of the Netherlands, each at the location on the map representing its original source, so that visitors can appreciate the distance each travelled when carried by the ice sheet. For convenience, a viewing mound was provided and there are two interpretative displays related to the map and to the exposures to be seen in the pit faces (photo below). The locality now forms one component in a nature trail designed for use by cyclists.

Public attraction

G. Gonggrijp

Management

Earth science sites, similar to "De Zândkoele", can often be established through representations at a local level, especially if there is little potential for alternative and conflicting land usage. Close co-operation with local residents and the local authority is essential in the establishment of such sites and adoption by a local geological society or conservation body is a good guarantee for future management. In both cases, the more the geological monument arouses feelings of local pride, the safer is its future. ■

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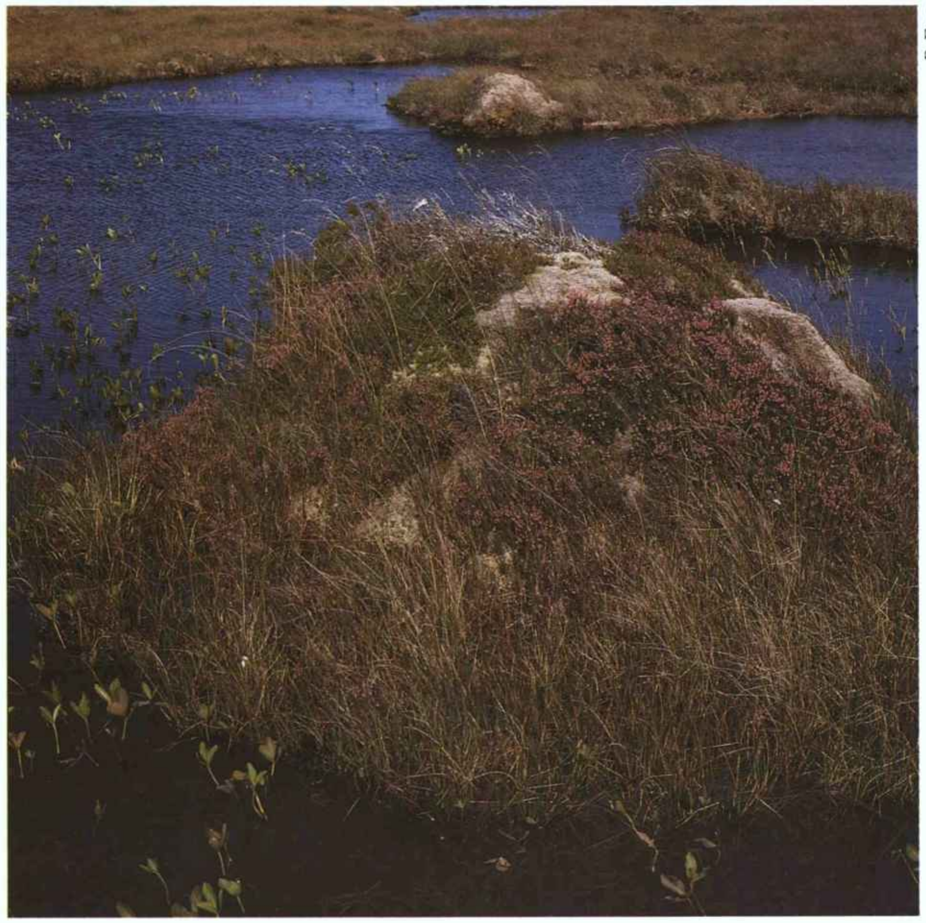
Irish peatlands

Valuable heritage

Donal Daly


P. Foss

Think of the natural beauty of Ireland and what comes to mind? Perhaps an image of rolling green fields, or of the Lakes of Killarney, or of the surreal limestone landscape of the Burren in County Clare, but whatever it might be it will undoubtedly include the wild boglands or peatlands. This is understandable—they are a scenic and extensive landscape feature and, although under increasing threat, many are still relatively undisturbed.

Mention boglands to the Irish people and the automatic associations will be many and varied—unproductive farmland; peat cutting for fuel and the generation of electricity; beautiful landscape; an inspiration for poets and artists; bleak, wet and soggy areas; unique ecosystems; a hindrance to development; a brown and purple wilderness; tourism potential. In these reactions lie the future of Irish peatlands, for they reflect cvonflicting experiences and views as to the utilisation of a natural resource and hold the answers to a series of questions. Which will predominate, conservation or destruction? Will increasing pride in this aspect of our natural heritage bring about successful conservation? Will concern for our environment and the economic benefits of cultural and eco-tourism avert destruction? The omens are good, but the time available is short, perhaps too short!

Formation and distribution

Peatlands (or mires) are accumulations of waterlogged vegetable matter topped by a surface layer of living plants. Water plays a vital role in peat formation as it acts as a preservative against decay by excluding the entry of oxygen. Consequently, peatlands form in wet areas where the rate of plant production exceeds the rate of plant decomposition.

In Ireland there are three types of peatland—raised bogs, blanket bogs and fens. The term "bogs" is used to describe peatland where the only water source is the rainfall; as a result such peatlands are acidic and poor in minerals. Fens, in contrast, are less acidic and often alkaline as the main water source is mineral-rich (usually calcium-rich) groundwater or surface water.

Raised bogs attain their finest development in Ireland where they cover large areas of the Midland limestone plain. Most have developed from fens—as the peat continued to accumulate, it formed a flattened dome, slightly higher than the surrounding areas—hence the name. Their peat consists largely of Sphagnum mosses and can reach thicknesses of up to 15 metres.

Blanket bogs, on the other hand, cover vast tracts, mainly in the wetter West of Ireland and in mountain areas. Their peat is less in thickness and, unlike that of the raised bogs, is more "grassy" in character, with little Sphagnum.

Extraordinary and special geological deposit

Peat is a fascinating and extraordinary geological material, although, despite its fascination, it is seldom studied by geologists in Ireland. It is the only sediment that, in its natural state, consists of living plants growing on the accumulated and now inanimate remains of their ancestors. Thus, at the same time, peat is both living and dead!

A striking characteristic is the high water content—five metres of peat may contain as much as 4.7 metres of water and as little as 0.3 metres of solid plant material. Water in peat, as in other rocks, is present in the free state in the pores but, unlike other rocks, water is an essential part of the structure of the peat.

Only a small proportion is mobile, although this varies with the hydraulic characteristics. As a consequence, the engineering and hydrological significance of peatlands is often complex and difficult to understand.

Peatlands are a major landscape feature and geological unit in Ireland as they cover 16% of the land surface—a higher proportion than in any other European country with the sole exception of Finland. As such, the wild open spaces provided by peatlands are part of the beauty, scenery and character of Ireland. Because of their ability to trap and preserve animals, pollen and other plant remains, they play a vital role in reaching an understanding of the geography of the last 10,000 years and this benefit is not merely academic or historical for evidence from the peat can be used to assist in the understanding and prediction of present and future pollution and climatic effects.


Friess-Irrmann

Peatlands are also major habitats for plants and animals, many of which are dependent on peatland for their survival e.g. certain species of Sphagnum and the Golden Plover. They provide valuable genetic resources, which arguably from a moral viewpoint should be conserved, but even from a utilitarian viewpoint, they may in the future be needed for the benefit of humankind, for food, medicinal and other purposes.

The development of peatland through extraction has provided significant economic benefits to Ireland, providing employment, fuel, electricity, goods for export and substitutes for imports. New peat-based products have been developed by Bord na Mona (the Peatland Development Authority) which have potential in the prevention of pollution. Peat is currently used to treat sewage effluent from septic tanks, to reduce odours, and to absorb heavy metals from industrial effluents.

Cultural and social influence

The historical, cultural and social influences of peatlands are varied and complex. Peatland encroachment overwhelmed Stone Age and Bronze Age settlement sites in parts of the west of Ireland, burying and preserving ancient field boundaries and cultivation ridges. Peatlands provided obstacles to communication and travel and formed a barrier to the exploitation of land; they also were a natural defence against enemies, a hiding place for treasures and bodies, a source of fuel by traditional peat cutting methods, and storehouses for perishable food, particularly butter. For some people—poets, artists, writers, musicians and others—they have been a source of inspiration but, for many people in rural Ireland, undeveloped peatlands were associated with hardship, poverty and disparaging comments. However, improved economic, educational and travel opportunities are causing a gradual change in attitudes so that there is now increasing national pride in our peatlands and a growing appreciation that they are part of our national heritage. The development of peatlands, particularly since commercial exploitation commenced in the 1940s, has brought prosperity, particularly to the Midlands—a prosperity which has brought major social benefits and which is now under threat as the peat resource is gradually being exhausted.

In recent times, the touristic potential of peatlands is being realised as cultural tourism and eco-tourism expand worldwide. Visitors, including scientists, are now coming to Ireland to appreciate a unique ecosystem, a beautiful scenic landscape and, in parts of the west of Ireland, an accessible wilderness area.

Peatlands under threat

Peat cutting drainage, afforestation and agricultural development have destroyed most of the peatlands of north-western Europe. Ireland remains as one of the last strongholds of peatlands, although this status is now under serious threat from human activities. As a result of drainage and extraction, only 7% of the raised bogs remain relatively intact. At the present rate of decline, except for six bogs already in part protected, all remaining wet, relatively intact, raised bogs of scientific interest will have been destroyed by 1997. Blanket bogs are being destroyed more slowly but, even so, afforestation, overgrazing and other human activities continue to spoil the integrity of these areas so that it is difficult to find extensive and undisturbed tracts which now survive. The conservation of peatlands is the most urgent issue confronting nature conservation—including earth science conservation—in Ireland.

Saving our peatland heritage

To conserve what remains of the Irish peatlands requires:

1. Improved legislative control over developments that threaten their interest.
2. An improved understanding of the hydrology and hydrogeology of peatlands to enable effective measures to be taken in their conservation.
3. Increased financial and staffing resources to allow the purchase of peatlands, the payment of compensation where this is necessary in the interests of conservation, the monitoring and management of conserved sites, and improved promotional and interpretative facilities.
4. Increased emphasis on the creation of greater public awareness and pride in our peatland Areas of Scientific Interest by conservation scientists and administrators.
5. Expansion of carefully planned and controlled tourism development based on conserved peatlands and providing alternative employment to peatland extraction and utilisation.
6. Further national and international encouragement and support.

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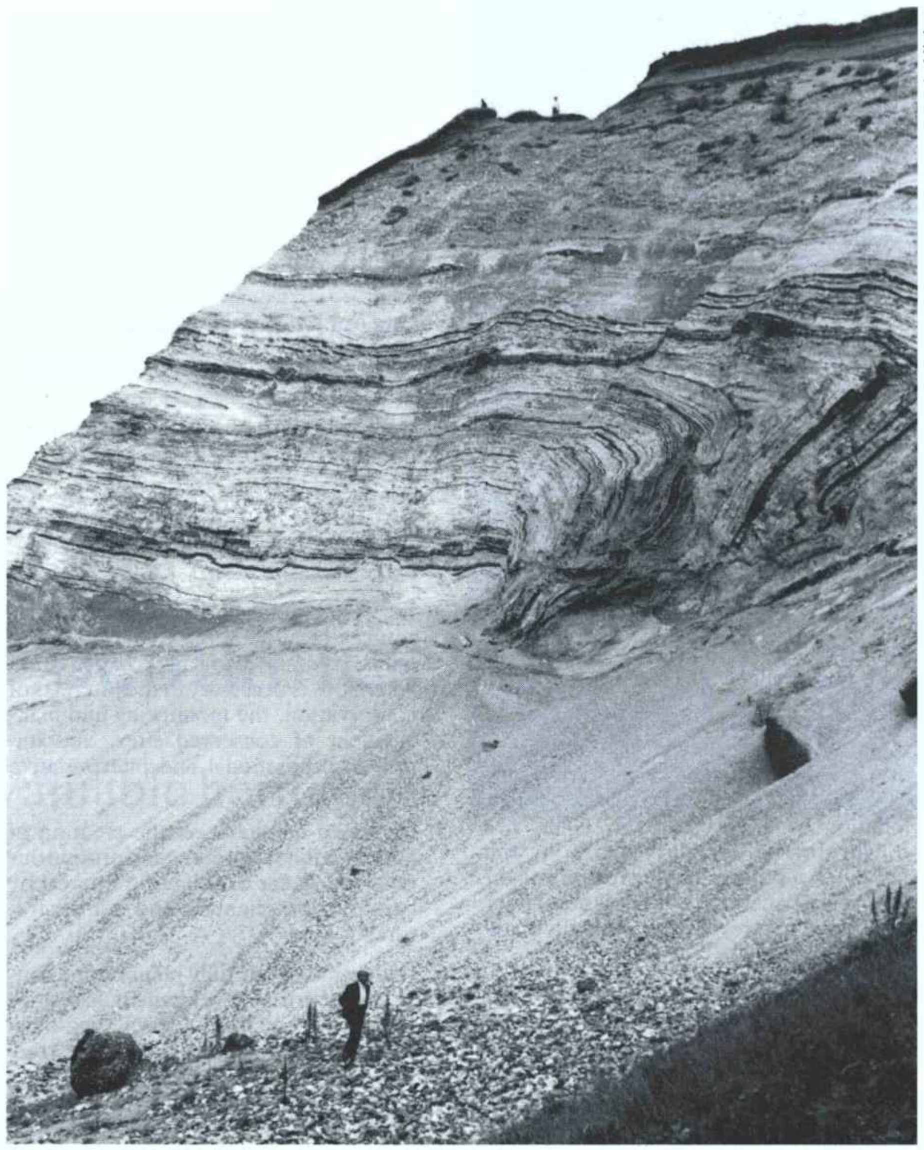

A. Nielsen

Hanklit

Danish cliffs

Arne Nielsen

Denmark is a small and low-lying country. The peninsula of Jutland and the 450 or so Danish islands of all sizes together have an area of only 45,000 sq km and nowhere rise to more than 173 m above sealevel. However, despite its small area, Denmark has a very long coastline which extends for some 7,325 km, about a hundred times the length of the land frontier with Germany.

The coast of Denmark shows a great variety of phenomena in its beaches, dunes and tidal flats and in its cliffs cut in both hard and soft rocks. Many of the eroding cliff faces are of great scientific and educational importance and some are recognised as of international value as standard reference sections.

Thanks to the Danish Nature Conservation Law, there is a general right of access to all beaches; in addition, a strip of land, 100 m in width, along the coast is protected from building and other human interference. On this basis, it has proved just as possible to conserve many localities of value to the earth sciences, as it has to maintain the tourist attractions along the coast.

Most of Denmark is composed of sediments laid down during the last 2.5 million years, an era known to geologists as the Quaternary. During this time, there were many periods of intense cold when an ice sheet, somewhat similar to that which still exists in Antarctica today, gathered over Scandinavia and then flowed southwards over Denmark. These glaciations have largely determined Denmark's geology and scenery—most of the country's surface has been carved in material brought from the north by the ice.

In its journey southwards, the ice sheet passed over older deposits of sand, clay, chalk and limestone. The ice dislodged great masses of these rocks and transported them from their original sites before later depositing them as giant rafts mixed in with its own glacial deposits. As can readily be imagined, these rafts were distorted by ice pressures when in transport and much can be learned about the flow of the ice from their study.

Each time a cold period came to an end, the ice sheet melted and the water from the melting ice modified the glacial sediments, over which it drained, to form a new suite of fluvio-glacial landforms. In addition, the growth and shrinking of each ice sheet caused fluctuations in sea-level and these are recorded by the features produced at the time by marine erosion and deposition.

Evidence for all these events in the prehistory of Denmark can be seen in the present coastal cliffs. These exposures owe much of their importance and interest to the continued work of the sea for they are kept clear and clean by present-day marine erosion. The examples quoted below serve to give some indication of the variety and importance of the earth science phenomena to be seen around Denmark's coasts.

Lonstrup Klint

This 12 km long coastal exposure lies on the west coast of Vendsyssel, Northern Jutland. Its central part—Rubjerg Knude—rises to 90 m above the sea and provides a section which shows up to 50 m of glacial and fluvio-glacial sediments, which were originally laid down horizontally, but which were later distorted and folded by ice movements during the most recent glaciation. These are covered by about 40 m of wind-blown sand, most of which has accumulated during the past 50 years. A lighthouse, out of action since 1956, has been almost buried by these new sand dunes. The cliff here retreats about 1.5 m per year and this serves to keep the exposures open for research and education.

Hanklit

The coastal cliffs around the western part of the Limfjorden in North-West Jutland provide exposures of the white diatomaceous clays with intercalations of black volcanic ash, known as the Mo-Formation and dating from long before the onset of the glaciations. These beds have been spectacularly distorted and folded by ice moving from the north during the last glaciation. The most important exposure is at Hanklit, a 65 m high cliff on the northern coast of the island of Mors.

Bovbjerg

Another important cliff exposure is to be found at Bovbjerg, on the west coast of Jutland. The cliff provides a very instructive north-south cross-section, almost 6 km in length, which demonstrates the so-called Ice-Border Line, a boundary important in the Danish landscape. This Line separates the south-western part of Jutland, which was not covered by the ice sheet in the most recent Ice Age, from the northern and eastern parts, which were covered by ice at that time. The limit of the ice on this occasion can be traded from Bovbjerg to Viborg and from there further southwards. The cliff reaches 40 m in height below the lighthouse and shows glacially distorted, ice-deposited sediments of various ages to the north and undisturbed gravels and sands washed out from the ice by meltwater to the south.

Stevns Klint

This cliff lies on the eastern coast of the Stevns Peninsule in South-East Sealand and reaches a height of over 30 m. Its exposures show Upper Cretaceous limestones, traversed by horizontal beds of black chert, below Lower Tertiary bryozoan limestone with layers of grey chert with a thin cover of glacial deposits above. This—the most significant type locality in Denmark—is of international significance and defines the boundary between the Mesozoic Era of earth history with the younger Tertiary Era, the actual junction being marked by a bed of dark marl (the so-called Fish Clay). The rocks seen at Stevns Klint thus span the period at which the dinosaurs (and many other groups) became extinct and were replaced by new faunas dominated by mammals.

Mons Klint

Mons Klint, the most famous and picturesque cliff in Denmark, lies on the eastern coast of the Island of Mons. More than 100 m in height, its face shows white Chalk broken by green patches which mark where material, now vegetated, has fallen from the overlying glacial deposits. The rocks have all been glacially distorted and deformed and the Chalk has been broken into 50 or more overthrust slices whose bedding can be seen from the bands of flint and chert to be steeply, or even vertically, inclined. Between the slices of Chalk are found parts of the sequence of glacial deposits which once overlay the Chalk before this was fractured and displaced by later ice movement.

Bornholm

Bornholm lies in the Baltic Sea between Sweden and Poland. Its rocks are much older than those of the rest of Denmark and have been brought to the surface due to movements within the Earth's crust. Its north-western coast provides exposures of ancient granites and on the south-east there are coastal exposures showing the island's history over a period of about 500 million years—from the deposition of rocks containing early fossils to the deposition of the Chalk.

These examples are sufficient to show the importance of the contribution made by Denmark's coastal cliffs to the study of the geological history of Northern Europe. In addition, these cliffs have an important role in the education of future generations of geologists. Fortunately many of the sections they provide are protected by the Nature Conservation Law and the remainder are registered as National Geological Localities of national and international interest.

If these cliffs are to retain their value to science, it is most important that they should continue to be subject to the cleansing action of the sea, for it is only through marine erosion that their interest is maintained. Coastal "protection" should not be allowed to interfere with this work of nature for natural phenomena are the basis of all culture and the rocks which underlie the landscape are the foundation for all other natural phenomena. We thus have a cultural duty to conserve our geological localities. ■

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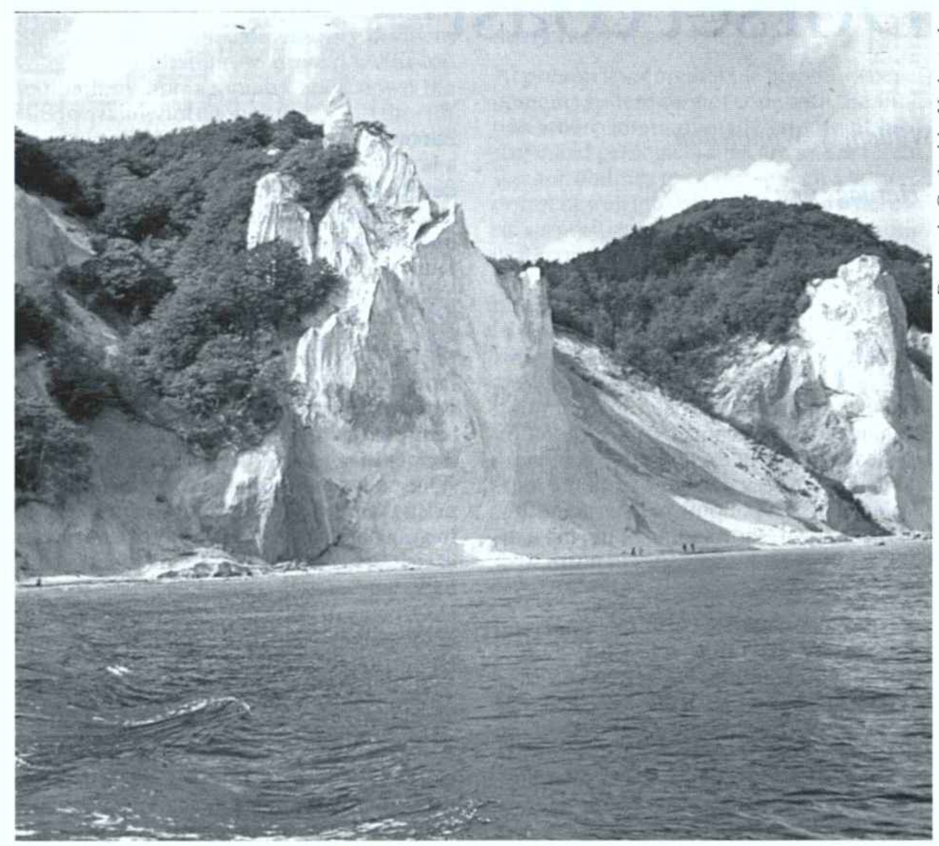

Denmarks Geologiske Undesøgelse

Mons Klint

W. A. Wimbledon

The cliff and landslip area of Lyme Regis built up by 190 million year old Lias rocks has been famous for its giant fossil reptiles and ammonites for more than two centuries.

The Dorset coast

William A. Wimbledon

"Heritage first!—or last?"

The County of Dorset is one of the gems of England's south coast and its Wessex landscape has been an inspiration for many artists and novelists. Its attraction is, at least in part, due to its underlying rocks and its 120 km long coastline from the massive landslips of Axmouth to Bournemouth, its largest town, shows some of the most diverse geology and landscapes in north west Europe.

Alternations of hard and soft rocks have led to a variety of, often colourful, coastal landforms—including the fretted coastline of Poole Harbour, one of the largest natural harbours; the rock arches and coves of the Lulworth Fossil Forest area and, further west, the 30 km long shingle tombolo of Chesil Beach, described as one of the natural wonders of the world.

For these reasons the county has always been a honey pot and a training ground for students of geology and geography. For those researching Earth history (stratigraphy), it is one of Europe's most important areas, containing some of the best places to see rocks dating from the age of the dinosaurs, laid down for the most part in ancient seas, between 200 and 60 million years ago.

Dorset's geology proclaims that Britain is very much part of Europe, despite any political opinions to the contrary, for its rocks and their fossils cry out to be compared to, for instance, those of Normandy or of the Boulonnais or Wurtemburg. In the last century, continental geologists such as D'Orbigny came to visit British sites. The completeness of the rock and fossil record in Dorset led D'Orbigny to take certain of its coastal cliffs as the global comparative standards for major portions of geological time (called by geologists stages)—horizontal slices through the enormous layer cake which is the Earth's crust.

Dorset's geological fame dates back to these and to earlier studies in the late 18th and early 19th centuries when the first discoveries of ancient life led to a realisation that the Earth was much older than had previously been believed, and that the relative ages of the rocks could be determined by the different fossils found in them. Dorset continues to be the subject of much research and interest. Since the earliest days of the science, more than 3000 papers and books have been published on the county's geology.

Tourism and science

Tourism in its broadest sense came to Dorset at about the same time as the first geological revelations. Visits by George III to Weymouth were a spur to the upper classes to come and take the air. Large hotels grew; in Victorian times the coming of the railways brought mass developments of holiday and retirement homes for a growing middle class, followed in the present century by a flowering of caravan sites. In the last fifteen years, road improvements have put Dorset within a few hours of the major centres of population, and the growing numbers of visitors have been a catalyst for speculative developments of more housing, marinas, wind-surfing centres and the like. The net effect of these is, of course, to alter and in some cases to totally change the very scenic coastline which attracted the visitors in the first instance.

Today's pressures on the geology and landscape are the construction of new man made structures and their protection from the natural processes (slope erosion, landslipping and wave action), which always have acted, and always will act on the coast. In some areas, such as the Bournemouth cliffs, the beaches are artificially nourished, the concrete aprons and promenades are continuous and the cliffs are graded and artificially vegetated—there is nothing natural left. In other areas, some of them internationally the most important for their rocks and fossils, the process has not gone so far but local priorities continue to take precedence over the preservation of our landscape and scientific heritage.

Housing developments which should not have been allowed close to cliff tops are now the trigger for applications for sea defences and the grading and loss of the natural cliffs. Undeveloped stretches of coast close to towns are becoming fewer and these are coming under increasing pressure from speculative developments. Only in those areas controlled by the army or large private estates does rural peace prevail.

W. A. Wimbledon

Chesil Beach has suffered great damage and disturbance through various schemes over the years.

Examples

I shall cite just three examples of internationally important sites where nature and geology have come into conflict with modern society. The first is Chesil Beach, an enormous storm beach which has been overtopped by exceptional storms many times in recorded history; there are accounts of large merchant ships having been carried over its top to be refloated in Portland Harbour. The modern answer to these perhaps once in fifty year flood events has been to build a storm drain parallel with the crest back of the beach, destroying the contours of the feature and contaminating the body of the landform with foreign rock introduced onto the site for construction. The irony is that no one knows if the drain will work when the exceptional storm comes, but it is certain that a unique piece of landscape, perhaps dating back to before the last Ice Age, has been irretrievably damaged.

The second instance is of the 100 m high Jurassic cliffs of the Isle of Portland, one of those sections recorded by D'Orbigny as being good enough to be the world standard for this piece of geological time (the Portlandian Stage). There the local authority decided, without consultation, to protect a cliff-top footpath by tipping quarry spoil down the cliff; certainly not enough to support the cliff and the path, but sufficient to obscure a section that scientists come from all over the world to see. The wild undercliff of Portland is inaccessible and so only time and weather can wash away the remains of this futile action.

The third instance is at Durlston Bay. There the Purbeck rocks record a dramatic change that occurred over large areas of Europe at the end of the Jurassic Period and the start of succeeding Cretaceous times. What had been sea for the previous 60 million years became emergent land, with lakes and lagoons teaming with life. Durlston has been a famous source of unique early mamals (some of the first described in the rocks of the age of dinosaurs) as well as fossil turtles, crocodiles, flying reptiles, lizards, dinosaurs and fish.

However, twenty years ago, a block of flats was constructed close to the cliff top and on a major fault line in the middle of an otherwise natural cliffed bay. This was done despite opposition from geologists and conservation bodies. The cliffs eroded and, in 1989, 2 million pounds was spent to support the building. An enormous cone of rock debris has been tipped down the cliff to give this support. Many have said that demolition of a building, which should not have been built, and compensation to the owners would have been a better and less damaging option for this heritage coast.

At present it seems that the planning (development) system cannot cope with the situation where internationally important landscape and geological sites are under threat. Responsibilities to conserve such a heritage do not fit well into a local situation where local authorities and councillors regard continued economic growth and anything that will attract more tourists as the absolute priorities. Sadly such ends can ultimately only be compatible with total urbanisation and the loss of all that is natural. ■

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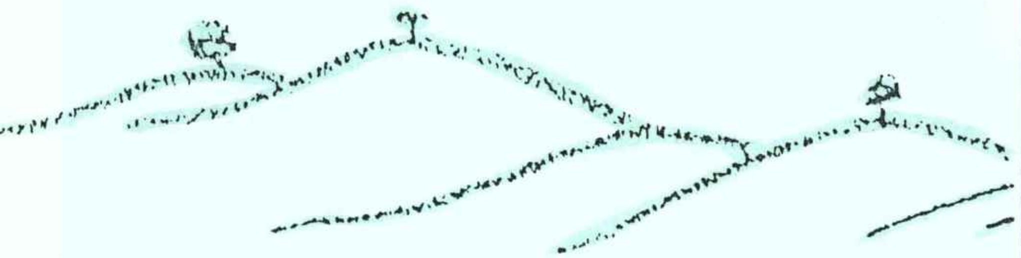


Swiss moraines

Bruno Stürm

Since the earliest times, mankind has been changing the face of the earth. In the past he proceeded gradually, and his response to natural phenomena was more sensitive, imaginative and discriminative than is the case nowadays. The landscapes fashioned in this way had a distinctive character and created a harmonious effect. Modern techniques allow increasingly drastic changes to be inflicted on the texture of the land and the balance of nature: landscapes are rationalised and cleared of whatever appears to be of no use; they are "domesticated", robbed of their specific character and their originality. The geological and geomorphological evidence of thousands or millions of years of landscape building is among the principal victims. Most of the damage is done unconsciously and can be put down to mankind's failure to appreciate the interrelationships and the values at stake. But with information that is factually correct and appropriate basic principles for legislation and planning, the process may yet be channelled in the right direction.

Physiographical feature worthy of protection

The moraine landscape on the edge of Switzerland's central plateau, between the Rivers Sihl and Lorze (Canton of Zug) will serve to illustrate the point.

Albert Heim, the celebrated geologist described this area as the most magnificent landscape in the country. Where it has escaped the severest onslaughts, it has every appearance of an unspoilt rustic landscape with typical old farmhouses to delight the eye, as well as fine cherry and pear orchards and marshy dells. Particularly attractive and conspicuous are the numerous lime-tree covered hummocks which local people refer to simply but affectionately as "Höger". This unique, impressive physiographical feature came into being as a result of the combined action of two major ice masses:

A transverse valley cut in the bedrock before the ice age assisted the advance of the Linth/Rhine glacier from the basin of Lake Zurich towards that of Lake Zug, occupied by the Reuss glacier. As the glaciers moved into the previously ice free area from both sides, ice reservoirs were formed in which varved sediments were deposited. Strong meltwater inflows led to large-scale aggradation. As the ice masses moved forwards, they eventually covered up the materials deposited in the intervening space. Most of the "Höger" are drumlin-like lateral moraines formed in the phase of glacial advance and subsequently covered over.

P. Studer

At the time of their maximum extension during the Würm glaciation, the two glaciers merged over a distance of some 5 kms. In the south-western part of the region, one can discern four maximum stages of the Linth/Rhine glacier. The corresponding terminal moraines, outwash fans and meltwater troughs have left their mark on the physical appearance of this region to this day.

As a result of warmer climates, the glaciers retreated. Because the floor of the Linth/Rhine glacier was only very mildly sloped, unlike that of the Reuss glacier, its recession steps are more pronounced and more sharply segmented. Evidence of glacial retreat in the landscape include moraine walls, meltwater troughs and dead ice depressions, many of which are silted up.

Conflicts

Situated on the edge of the Zurich conurbation, between the Rivers Sihl and Lorze, this moraine landscape suffers from increasing development pressure. The boom in the building industry has caused the demand for gravel and sand to soar to unprecedented levels. On average, a million cubic metres of material have been excavated every year for the past five years. Reserves in respect of authorised quarrying schemes amount at present to approximately 10–15 million cubic metres. Other reserves totalling some 40 or 50 million cubic metres are not authorised for exploitation although their volume and structure would permit this, according to current economic and technical parameters. With the market under such strain, this represents a huge potential source of conflict.

While it is true that the consequences of industrial operations can be mitigated by careful selection of gravel-pit sites and appropriate landscape restoration, there are limits to what can be achieved: lack of rock-fill or of suitable materials for the purpose, the demands of water protection and the farmers' interest in having land that is as even and as easy to cultivate as possible, are considerations which restrict the landscape artist's scope; valuable features like drumlins and moraine walls can at best be reconstituted after the manner of the originals and on the same spot; but their substance and internal structure are lost for ever.

Only in the last few years have people become aware of the special significance and uniqueness of this moraine landscape, and of the threat that hangs over it. Public opposition to new quarrying schemes is growing.

Solution in sight

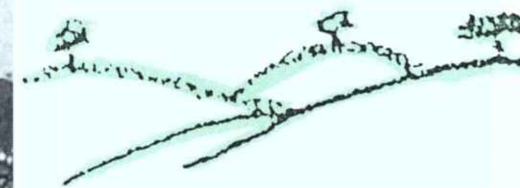
The instruments available to the authorities for guidance and co-ordination have been steadily improved under pressure from public opinion.

With the introduction of planning measures, areas for gravel extraction have been strictly demarcated. They are mainly limited to areas there this use has been autorised before.

To achieve maximum economy in the use of mining grade reserves, a quota system has been imposed by law to fix the amounts of material that may be quarried annually. In the area of moraine landscape between the sine and the Lorze, the present figure is around 800,000 cubic metres.

Under the 1988 Act on the protection and maintenance of the moraine landscape, no new quarrying permits may be granted. The rules may, however, be waived to permit schemes that are demonstrably in the public interest to go ahead.

To ensure that all interests are duly taken into account, the moraine landscape between the Sihl and the Lorze has been entered in the Federal Register of landscapes of



national importance. This ensures that it receives maximum protection under the Federal Nature and Heritage Protection Act. Even so, the future of the moraine landscape area remains uncertain in so far as the growing scarcity of raw materials could justify the gravel suppliers' claim to be acting in the public interest.

Conclusions

Gravel, sand and other mineral resources are irreplaceable in the same way as unspoilt landscapes, and must therefore be used economically.

The currently applicable legal texts and planning instruments empower the authorities to keep gravel quarrying under control in the moraine landscape area and to safeguard this valuable physiographical feature. However, the problems associated with gravel supply have not been solved satisfactorily, but only shifted into other sectors. No-one yet knows how the intervention system thus established will react to the next rash of development.

The need now is for a supraregional plan to ensure that the commercial exploitation of raw materials is economic and at the same time respects the landscape and the environment. To ease the market, every encouragement must be given to the use of gravel substitutes. ■

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Finnish eskers

Osmo Kontturi

All countries have their own characteristic landscapes whose evolution is a result of an interplay of natural, historical and anthropogenic factors. All parts of the world are now influenced by human activity and it is therefore becoming more and more worthwhile to conserve natural landscapes as they are today, especially if they are examples of some rare or uncommon variety. The glacio-fluvial, or esker, landscapes of Finland are a case in point, having developed through the interaction of geological, biological and socio-economic processes over the past 12,000 years.

These landscapes date from the end of the most recent glacial period and were formed at a time when the Scandinavian ice sheet was wasting away. They originated, either under the ice, or at the ice front, through the action of meltwater. Deposition and erosion of sand and gravel led to the production of a great variety of the so-called glacio-fluvial landforms, ranging form flat fans to knobs and ridges, but the most striking is undoubtedly the esker, a meandering sand and gravel ridge which can be tens of kilometres long, and which is aligned parallel to the direction of ice movement.

Internationally valuable asset

By definition, glacio-fluvial landscapes are restricted to areas of past glaciation. In Finland, they form some of the most beautiful scenery, especially where combined with lakes, mires and rivers. They have a unique vegetation which contains a number of rare species. In spite of its poverty and lack of variety in biotopes, the typical esker vegetation offers habitats for a number of species of animal—for example, the wild forest reindeer, semi-domesticated reindeer and various birds such as the tree pipit and the nightjar. Such factors have been taken into account when the conservation of glacio-fluvial landforms has been in the balance.

The slopes of eskers frequently show the marks of ancient shorelines at various heights and these tell of fluctuations in the level of the Baltic Sea or of local lakes. Former shorelines are known to have been important to Stone Age Man who used them for fishing and who built his houses nearby. Research into the natural history of these ancient shorelines often yields results which can be used to estimate the dates of prehistoric dwelling sites.

Conflicting land uses

Although human activity in esker areas can be traced back to prehistoric times, human impact on glacio-fluvial landscapes is largely restricted to the last few centuries, with virtually all the major changes having been effected in the last 20 to 30 years.

Today, the glacio-fluvial deposits of sand and gravel are subject to a wide variety of partially conflicting, and partially compatible forms of land use, including extraction of gravel, supply of groundwater, building, recreation and nature conservation.

Many camping sites, sports centres and tourist centres have been established in glacio-fluvial landscapes but, unfortunately, their attractive and highly varied scenic landforms have not proved sufficiently resistant to such treatment. This has led to mild conflicts between tourism and nature conservation.

Major environmental conflicts arise over gravel extraction. Although the total consumption of gravel is very small in comparison to the gross resources, extraction has caused considerable damage to the environment e.g. by harming beautiful esker landscapes, increasing risks to groundwater supplies and by restricting the recreational use of esker areas. For economic reasons, gravel cannot be transported over distances of more than 60–70 km (and sometimes much less) and the gravel resources of Finland are somewhat unequally distributed on a regional scale, with many areas rich in gravel having only a low level of demand. There is therefore great pressure to extract the limited resources near the major towns and cities so that natural glacio-fluvial landscapes have largely disappeared from within 40–60 km of all the larger population centres in Southern and Central Finland, such as Helsinki.

This forms the background to the scientific assessment of eskers as part of the case for their conservation and to the obligation to preserve untouched samples of natural glacio-fluvial landscapes for future generations.

Investigations and planning

The first definite moves towards the conservation of glacio-fluvial landscapes in Finland date from 1972 when a nationwide investigation of eskers, financed by the National Bureau for Nature Conservation, was begun. The principal aim was to gather together all information relevant to planning the future land use of the glacio-fluvial areas on a national basis. This was done in two phases, the first—the preparation of an inventory—being carried out in the 1970's under existing legal powers for nature conservation, and the second—in which new methods of investigation and analysis were developed and the inventory was updated—took place after new laws governing sand and gravel extraction had been passed in 1982.

The first stage in the preparation of the inventory was the identification of glacio-fluvial landscapes on the Basic Map of Finland and this was followed by traditional fieldwork supplemented by oblique air photography and, to some extent, Landsat images. Each area was classified on the basis of its geological, geomorphological, biological and landscape character and a recommendation was made regarding suitable future forms of land use. Data were collected for 1,765 esker areas, with a total land area of some 240,000 ha—approximately 25% of the total area of glacio-fluvial landscapes in Finland. Most glacio-fluvial landscapes lie in Northern and Eastern Finland—the most remote and sparsely populated parts of the country.

A. Lyytikäinen

Even before the Extractable Land Resources Act came into force on 1 January 1982, two Ministries had been involved with planning for the conservation of glacio-fluvial landscapes. A working group in the Ministry of Agriculture and Forestry had collected data from 1977–80 with the aim of drawing up a co-ordinated national programme for esker conservation and the Planning and Building Department of the Ministry of the Interior, from 1976–80, had surveyed esker areas of national significance. The results obtained were combined and reviewed by the new Ministry of the Environment which was set up in 1983. The outcome was a national programme for esker conservation which was ratified by the Council of State in 1984 and which covers 159 esker sites with a total area of 96,000 ha. In addition to the sites included in this national programme, many areas of glacio-fluvial landscape are recognised at a regional level, e.g. through being included in the lists of conservation and recreation areas drawn up by the Regional Planning Associations.

Conservation in practice

In legal terms, the protected glacio-fluvial areas of Finland are:

1. Parts of nature reserves or national parks, with the status of state land;
2. privately owned land which has been declared a nature conservation area;
3. special forest areas, designated as such by some government agency, usually the National Board of Forestry. The total area protected is about 15,000 ha, or about 1.5% of the area of glacio-fluvial landscape in Finland. In terms of the targets set, this is obviously quite inadequate.

For example, the Salpausselkä End Moraines—in international terms, the most significant formation in Finland in the field of Quaternary Geology — are represented in only five conserved areas, all in the southwest. Since features of this type have a significance which extends to all Nordic countries, to Soviet Karelia and to North America, and since they are liable to destruction over most of the Nordic countries, their protection, as first proposed by the Nordic Council of Ministers in 1973, is a matter of international concern and should be a matter of international co-operation. The failure to follow up this proposal is therefore a challenge to earth science conservationists, especially those interested in the Nordic countries and Karelia; the lack of interest in the conservation of glacio-fluvial landscapes must also concern their colleagues in Central Europe where there are remnants of glacio-fluvial landscapes and geotopes produced by earlier deglaciations. ■

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At the Council of Europe

A new initiative of the Committee on Agriculture aims at stopping soil and water pollution by nitrates, phosphates, heavy metals and other pollutants caused by manure from intensive animal production. The Committee, in its report, stresses the importance of restoring or safeguarding unpolluted soil and ground water resources which are of fundamental importance for the production of quality food. It asks in particular for improvements on storage and spreading regulations in member states in order to avoid that the application of animal manure on farmland should result in any degradation of the environment but should rather improve soil and soil fertility. This implies setting maximum limits on quantities applied as a function of soil cultivation and manure quality. It also necessitates rules for storage, application periods and application technology as a function of geography, climate and habitation.

Soil pollution and the consequences for agriculture was also one of the main concerns of the first European Agricultural Forum which was organised from 2 to 4 May by the Committee, in co-operation with the Austrian Federal Ministry of Agriculture and Forestry and the European Confederation of Agriculture. It was attended by some 200 representatives of governments, parliaments and the agricultural profession from Central, Eastern and Western Europe. The Forum expressed the concern that soil pollution and soil erosion represented a threat not only to agricultural production in Europe but in fact it could endanger world food security.

In 1986, the Committee presented a report to the Parliamentary Assembly in which it put forward a recommendation that member governments should give far more importance to their soil protection policies. ■

The European Regional Spatial Planning Charter, the so-called Torremolinos Charter, which was adopted in 1983 by the European Ministers responsible for Regional Planning, sets out the fundamental objectives of regional spatial planning.

Among other things, the Charter states that regional spatial planning seeks to ensure responsible management of the environment and the resources of land, sub-soil, air and water, as well as achieve the rational use of the land.

In 1988, the 8th session of Ministers responsible for Regional Planning took these guidelines as a basis for discussing land use problems, with particular reference to the quantitative use of land. In the resolutions they adopted, the Ministers expressed their concern at "the increasing tendency in recent years to use land for immediate needs without sufficient regard to the needs of posterity or of nature".

They noted that land was a limited, non-increasable resource which could be difficult and costly to recover and which should therefore be properly protected. They also stressed the interdependence of the quantitative and qualitative aspects of soil/land protection and the interaction between spatial (land use) planning policy and environment policy.

Land versus development

People are now beginning to appreciate the true value of land as a resource limited in quantity. It has been realised in a number of countries that socio-economic development consumes vast amounts of land every day and that this trend needs to be controlled if the wastage and indeed permanent loss of good-quality land is to be avoided. Hence the call for the rational use of land. At the same time, however, rational land use should not hamper economic activity and development, since they play a key role in our well-being and standard of living. Consequently, an acceptable balance needs to be found between, on the one hand, policies to protect and preserve the environment and, on the other, the demands of present-day socio-industrial development.

The Ministers acknowledged the existence of a conflict which should be resolved by an active policy of rational land use. With a view to facilitating the implementation of suitable policies at national level, they included in their final resolutions a set of principles on built-up areas, agriculture and the countryside.

Instruments for rational land use

After analysing the main problems arising from land consumption, the Ministers went on to consider the instruments with which the objectives outlined in Lausanne might be achieved. First priority, in their view, was to develop, on the basis of the principles they had adopted, some instruments for promoting, implementing and managing a policy of judicious and restrained land use.

At their 9th session, in Ankara (Turkey) in October 1991, the Ministers will discuss the various ways of improving instruments for achieving rational use of land. These include:

- information instruments (e.g. cartography, remote-sensing and databanks), and monitoring instruments
- regulatory instruments and incentives (e.g. fiscal measures and impact studies);
- socio-political instruments (e.g. an integrated policy of local and regional development, and co-operation between public authorities and the private sector).

International problem

Because the problem of land use in a new and complex subject which in the past was dealt with only at national level, there is a need for international co-operation in the form of the pooling of information and experience regarding research and the application of its results. At present no machinery for co-operation or documentation exists in this field on a Europe-wide scale. At national level, some land observatories have been set up, and the experience acquired by them could be of interest to other countries.

The Ministers' discussions might therefore lead to the following conclusions:

- the various instruments will not become fully effective until individuals and institutions have recognised that land is a separate entity and a limited natural resource;
- conceptual and operational instruments for rational land use can enable urban and industrial development to be reconciled with soil protection provided that the physical integrity of land is respected and the concepts of functional flexibility, reusability and ease of demolition are accepted in respect of buildings;
- satisfactory vertical and horizontal co-ordination of instruments for rational land use should increase their efficiency, priority being given to the idea of sustainable development;
- a European campaign for rational land use and sustainable development might be organised to alert the public to the problems described above and promote the implementation of relevant national policies. ■

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