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Pan-European landscapes

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Abstract

As a supplement to the western European typology from *Landscape and Urban Planning*, 18(3–4): 289–352 (Meeus et al., 1990), a survey is made of the landscapes of northern and eastern Europe. Thirty landscapes are identified on a continental scale. This pan-European landscape typology is based on the integration of landscape formation factors. The basis for a regionally differentiated geography, morphology and scenery of the man-made landscape is provided by land form, soil and climate on the one hand and regional culture, habits and history on the other. This typology can be used as a reference for a discussion about the actual appearance of the landscape. The map of European landscapes is only a reconnaissance and is therefore not intended as a blueprint for action, but rather as a way of looking at landscape heterogeneity, a set of principles to stimulate the discussion of landscape development throughout the continent.

Keywords: Europe; Landscape; Typology

1. Introduction

1.1. *The definition of landscape*

Man's activity over centuries has resulted in the formation of man-made landscapes, which are thought to be natural but have been shaped by man. The landscapes of Europe are very complex. Variations in climate, soil, landform and land use ensure a wide range of environments. These in turn create a whole variety of habitats, wildlife species, natural resources and places for people to live, work and relax. There is probably no other place on Earth where the interaction between man and nature, expressed in landscape, is so heterogeneous.

By definition, 'landscape' is the physical surface of the Earth. Theoretically two types of landscape can be identified: first of all the 'nat-

ural' landscape formed by the forces of nature (tectonics, weathering, erosion, sedimentation and occupation under different conditions of climate and parent material) and secondly the 'cultural' landscape being the result of an interaction between man and nature.

In the European context, there are hardly any landscapes that can be considered 'natural' in the sense that there is no human influence whatsoever, and few where there is no human presence. Most landscapes are directly affected by human activities, such as hunting, forestry, pasturing or agriculture. Landscape is not simply, or perhaps mainly, something to look at, but is also something to live, work and relax in. Nature is not some independent entity; it is something that is there despite and thanks to everyday human activity. Although many parts of the continent are colonised and urbanised, there is still some sort

of natural diversity, giving distinctive character to countries, regions and local areas.

Cultural landscapes can be defined as recognisable parts of the surface of the Earth, which have a characteristic composition, structure and scenery. Landscape types are distinguished by the degree of anthropogenic influence and are defined by a particular configuration of land form, soil, topography, climate, vegetation, land use, history and scenery (Jellicoe, 1975; Noirfalise, 1989; Vroom, 1990; Meeus et al., 1990; Verhoeve and Vervloet, 1992; Farina and Naveh, 1993).

1.2. Goals and objectives

The purpose of this article is to put forward a typology of major European landscapes. The typology proposed is an attempt to generalise the characteristics of landscapes and to formulate a basic framework for assessing how natural and anthropogenic factors affect the development of the environment. It is a typology designed to give insight into the interrelations between the cultural and natural heritage of the whole continent. More importantly, however, the typology will become an instrument to develop international priorities for action in a European context that may serve as a guide to the sustainable development of natural resources. Landscapes need to be treated as environmental resources in the planning process, on national, regional and local level. If this essay succeeds in convincing the reader of the need for making landscape considerations an important factor in shaping strategies for sustainable development, it will have fulfilled its purpose.

2. Europe as a continent

The area of study is the European continent within the classical boundaries: from the west to the east, covering the whole area between the Atlantic coast and the Ural Mountains. In the north and the south the area is bordered by the Arctic Ocean and the Mediterranean Sea, the northern coast of the Black Sea, the Caucasus Mountains

and the lowlands in the western part of the Caspian Sea (Fig. 1). The total surface area is 950 million ha. While more than two-thirds of the total European population live in urban areas, only 1% of the total land area is directly in urban use (10 million ha). Thirty per cent of the continent consists of tundras and mountains. Roughly 45% of the total land area is used for agricultural purposes and about 25% is forests. These areas are not exclusively available for production, they also serve as recreational areas and nature reserves. Depending on the function of tundras and forests and the degree of human influence on mountains and woods, man-made 'cultural' landscapes cover 70–90% of the continent (Csati, 1980; Kostrowicki, 1984; Agricultural Land Use Map of the USSR, 1991).

3. Cultivation and civilisation

Cultivation of the land was an essential preparatory act performed by advancing European civilisation, which started centuries ago. Replacing wilderness, man created landscapes after his own needs: permanent pastures, grasslands and arable lands, often intermixed with remaining woodlands, hedges, orchards and trees along roads and waterways. Incorporating geological, climatic and topographic conditions, man has shaped nature 'his way' in each region, thus creating a whole variety of man-made landscapes. The influence of man in making and controlling the landscape is obvious. Man-made landscapes differ more than might be expected on the basis of natural circumstances only. Landform and climate largely determine the possibility to grow and harvest crops, to graze the domestic herds and to maintain or introduce natural biotopes and habitats. Hunting, forestry, cattle breeding, agriculture and urbanisation have changed the original conditions for growing and added new variations to the natural pattern. The fertility of the soil, the slopes, the parcelling, the agricultural traditions, the ownership structure and the rural road network determine the kind of crops to be grown.

The composition and the appearance of the



Fig. 1. An outline of the physical structure of Europe.

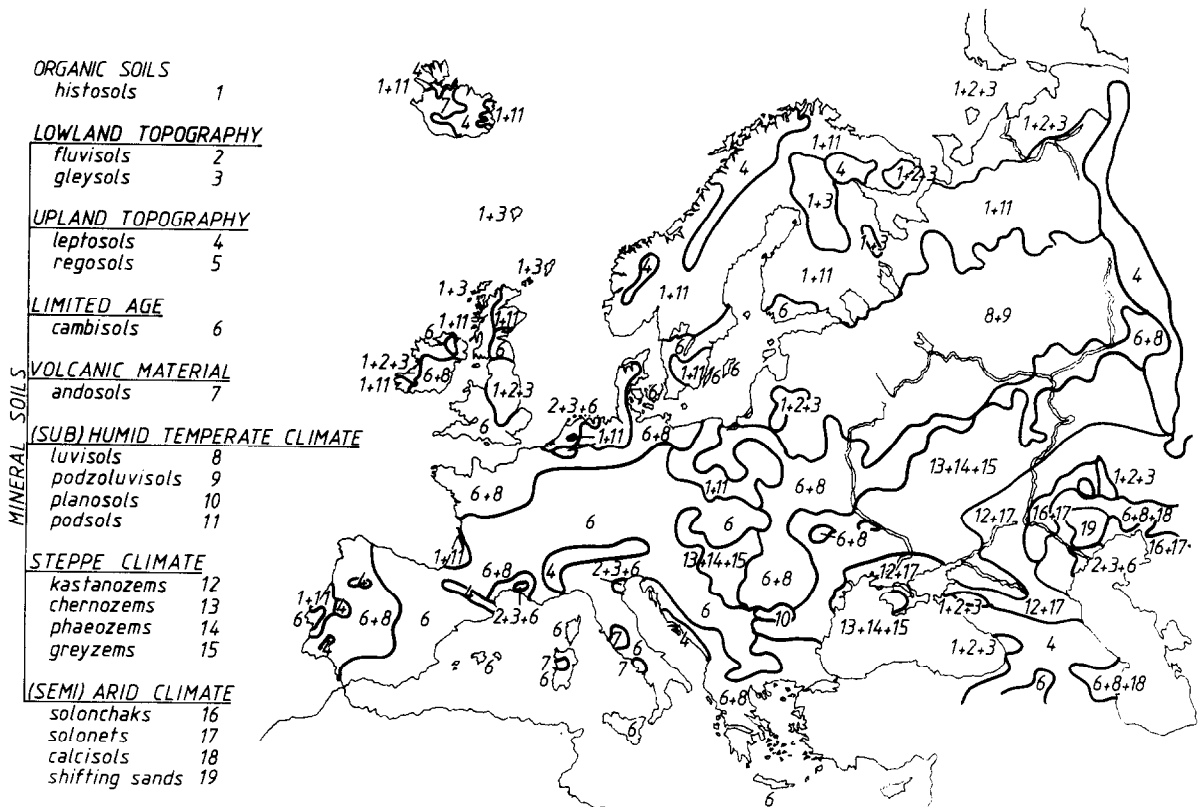


Fig. 2. Soil sets in Europe. After Tavernier (1985), Food and Agriculture Organization (1990) and Driessen and Dudal (1991).

landscape is called 'scenery'. Historically the main landscape types of Europe are the small-scale, enclosed 'bocages' on the one hand and large scale 'open fields' on the other, while there

are also mixed, forested and 'pastoral' agricultural landscapes (Luginbuhl, 1989; Farina and Naveh, 1993; Verhoeve and Vervloet, 1992).

There is a remarkable difference between the

land forms of western and eastern Europe. Natural soil and climate conditions are more extreme in the east and also more homogeneous than in the west. Population is less dense and land form follow the climate and soil zones more closely (Fig. 2).

Because of the diversity in climate zones and soil types there is a tremendous difference in growing conditions in Europe. With the differentiated agricultural techniques, regional consumption patterns and agricultural business styles this creates a whole range of regional landscapes. The regional culture leaves its mark on the landscape image and dictates the observation strategy. The key to landscape interpretation is the way in which a given culture handles the natural data of this specific site and turns them into an image.

4. Landscape typology

4.1. Immediate cause and approach

In the course of time each culture leaves behind its own landscape. This is in part explained by the dynamism of the landscape, in which harmony is created by the unique way in which soil, climate and topography combine with crops, natural relics, trees and built artefacts. The image is different for each landscape and is determined by a historical or current regional culture. A description is given in this article of the process of landscape formation and the accompanying image-building.

Art and communication media influence landscape observation strategies. Etchings and paintings by Dutch Masters, Blaeu's maps, Picturesque and Impressionists paintings, Hardy's landscape descriptions, Bauhaus's architectural photography and recent Russian and Czech cinema have all had their effects. They breathe a fascination with landscape composition, colour, setting and dynamism, directing observation and adding to cultural richness (Svobodova and Uhde, 1993). In this essay maps, diagrams and photos are used, since they allow the description of landscape location and composition.

Every typology has its own purpose.

(1) In the last centuries, the formation of national states involved a gradual decay of regional cultures, landscapes and languages. Anthropologists, geographers and historians made an effort to chart 'regionally specific' features of people and landscape, thus producing unique landscape typologies (Braudel, 1979; Balabanian, 1980).

(2) To enhance a country's national identity several landscape typologies were made, glorifying its own national inheritance and neglecting the link with the foreign context. National atlas typologies are difficult to compare, because of their difference in perspective, aim, method and cartography (Atlas of the USSR, 1984; National Atlas of Sweden, 1990–1992; Atlas Van Nederland, 1984–1990).

(3) The post-war growth of international transport and communication methods means an increase in scale and a levelling of agricultural production environments. These past 50 years have seen a rapid transformation of the landscapes of western and central Europe, a transformation adding to the differences between western, eastern and southern Europe. This resulted in a number of agriculture, soil, land use and landscape maps, in which boundaries are crossed (Lebeau, 1969; Vanzetti, 1969–1977; Csati, 1980; Kostrowicki, 1984; Tavernier, 1985; Romanova, 1988; Agricultural Land Use Map of the USSR, 1991).

(4) Scientists cannot agree about integral geomorphological and geobotanical maps for eastern and western Europe. Method, aim and cartography of maps covering the landform, vegetation and landscape of the former Soviet Union and the European Community are so diverse that comparisons are hard to make, if not impossible (Embleton, 1984; Noirfalise, 1987; Landscape Map of the USSR, 1988; Geomorphological Map of the USSR, 1989).

(5) The stimulus for international communication between western and eastern Europe points out the necessity for exchanging aims and methods concerning regional landscape identification. Awareness of the fact that the landscape is in danger of over-exploitation and erosion made the former Czechoslovakia draw up an

ecologically based landscape typology (Atlas of the Environment and Health of the Population of the CSFR, 1992).

(6) Probably because of the dominant human influence, (agri)cultural landscapes have only recently tended to attract attention from ecologists (Noirfalise, 1989; Park, 1989), although they have been studied by geographers since the 19th century. Apart from tundras, mountains and forests the values of grassland ecosystems, hedgerow networks and field margins (e.g. the banks of a ditch) are also recognised. In the 1980s and 1990s there has been increased attention for regionally specific identities and landscapes, motivated by ecology and scenic values.

4.2. *The paradox of regional landscapes*

Modern transport, communication, and agricultural techniques break open regional landscapes as it were, to create space for an international culture. This holds a certain paradox. On the one hand there is the diversity of regionally specific landscapes, appreciated for visual, cultural and ecological reasons, while on the other there is world-market production and consumption with their increase in scale and their levelling effects. International confrontation with regional landscapes creates both inspiration and a lot of confusion.

4.3. *Towards a pan-European landscape typology*

Because natural and cultural conditions are so diverse it is difficult to classify landscapes in a simple hierarchy that will apply to the whole continent. To understand how environmental problems and human activities interact it is essential to integrate different uses of land with their natural conditions and cultural expressions. Human interference has become an increasingly important factor since the advent of agriculture. The fact that most landscapes are by-products of human activities makes them vulnerable to the changes in management. Consequently, landscapes are in a state of flux; however, at some stage ecological and economic

activities can make them lose their optimum expression. The spatial and temporal trends in the composition of man-made landscapes are highlighted, with a special focus on the formation factors and the transformations that take place in various landscapes.

With this complexity in mind it is not possible to identify a single approach for analysing landscapes which suits all purposes. At the moment there is no generally accepted system of landscape classification on a continental scale. Because of the many diverging connotations hidden in landscapes locally and regionally, a typology of continental landscapes must be multi-dimensional. The interaction of human activities and natural systems and the resulting scenery of the landscape are the most important dimensions. Thus geological, ecological, agricultural, silvicultural and visual criteria are used to determine the 'major landscapes' in Europe on the highest level of abstraction.

4.4. *Selection criteria*

In identifying the most important landscape types in Europe, six selection criteria might be applied.

(1) The landscape types have to represent the main land forms that characterise the geological and climatic zones. It is important to memorise that every landscape include different stages in the process of weathering, erosion, sedimentation and colonisation.

(2) The economic potential of land use and landscape should be recognised. Most of the time farming and forestry are the architects of the landscape, they play a significant role in the shaping of the landscape and many natural biotopes and habitats have been moulded by agricultural use over time. On the other hand mechanisation of farming and forestry have brought about the enlargement of plots, removal of hedgerows, abandonment of terraces and clearing of woods. Landscapes are the expression, so to speak, of past and present economic activities. But landscapes also have an economic value of their own through their importance for recreation and tourism.

(3) Efforts should be made to identify those landscapes that are characterised by a combination of ecologically sound processes and sustainable use of natural resources. The Scandinavian grazed deciduous woodlands and the Iberian agro-silvo pastoral and transhumance systems are examples of sustainable methods of land management, that have survived over the centuries, creating environments rich in wildlife. If sustainability is about people establishing a new relationship with the natural world, these landscapes can serve as a guide to future development in Europe.

(4) Account should be taken of the importance of extensively managed areas for the experience of nature and wildlife. In the absence of true wilderness areas in most parts of Europe, extensively used agri- and silvicultural landscapes have become the substitute. Upland areas, tundras and wetlands have important functions for this reason.

(5) The presence of regionally specific settlement patterns, ancient field systems, old trees, terraces and vernacular architecture is an obvious indicator of the local inhabitants' need to express their cultural heritage. Formerly, types of settlement had to be adapted to natural conditions, because there were no techniques to master and control them. Old land and road patterns tell a tale of the history of the site. Since the landscapes we find in Europe today express man's alliance with the land, they are often imbued with rich cultural connotations.

(6) Account should be taken of the scenic quality and the visual characteristics of the region itself. Landscapes are often associated with harmony, nature and openness. Green spaces around urban settings are seen as peaceful oases in hectic environments. However, metropolitan areas and taigas, with their seemingly endless maze of densely built and forested areas, may give a feeling of suffocation. Landscapes are appreciated for being the opposite: open, less controlled and changing with the season. Scenery is the visual identification of the coherence between natural and anthropogenetic processes and patterns. The degree of openness betrays the human

influence and can be used to characterise the visual quality of the landscape.

4.5. *Thirty types of landscape on the continent*

On the basis of the existing typologies and the criteria mentioned above, thirty types of landscapes have been identified. In developing continental landscape types some attention will be paid to the fact that national or local landscapes like for example coastal, moraine or river landscapes, bogs, fens or brooks 'nest' within them. It is important to state that the typology and the map of European landscapes (Fig. 3) is only an illustration of landscapes that might be important to the continent as a whole. This report does not claim to be a conclusive European landscape inventory; such an inventory requires a more comprehensive programme of data collection of land form, land cover and land use, but also research on historical development, cultural heritage and different ways of expression of landscapes. The map as presented here (Fig. 3) is therefore not intended as a blueprint for action, but rather as a way of looking at landscape heterogeneity, a set of principles and proposals to stimulate the further discussion of landscape development throughout the continent.

4.6. *Uplands and lowlands: actual and potential vegetation*

The basic differentiation of the landscape in Europe corresponds to the distribution of landforms of the Earth's relief: 'uplands' and 'lowlands' (Fig. 4). The uplands, formed by mountain ranges and highlands, are characterised by their relief, active processes of weathering and erosion and by the variability of climate conditioned by both elevation and parent material. The lowlands are characterised mainly by the flat or undulating erosional relief which is formed through dynamic processes on depositions of various age. Most of the lowlands in Europe (e.g. polder, delta, huerta) have lost their original wetland character by reclamation, drainage and irrigation.

With the help of a so-called 'Holdridge' dia-

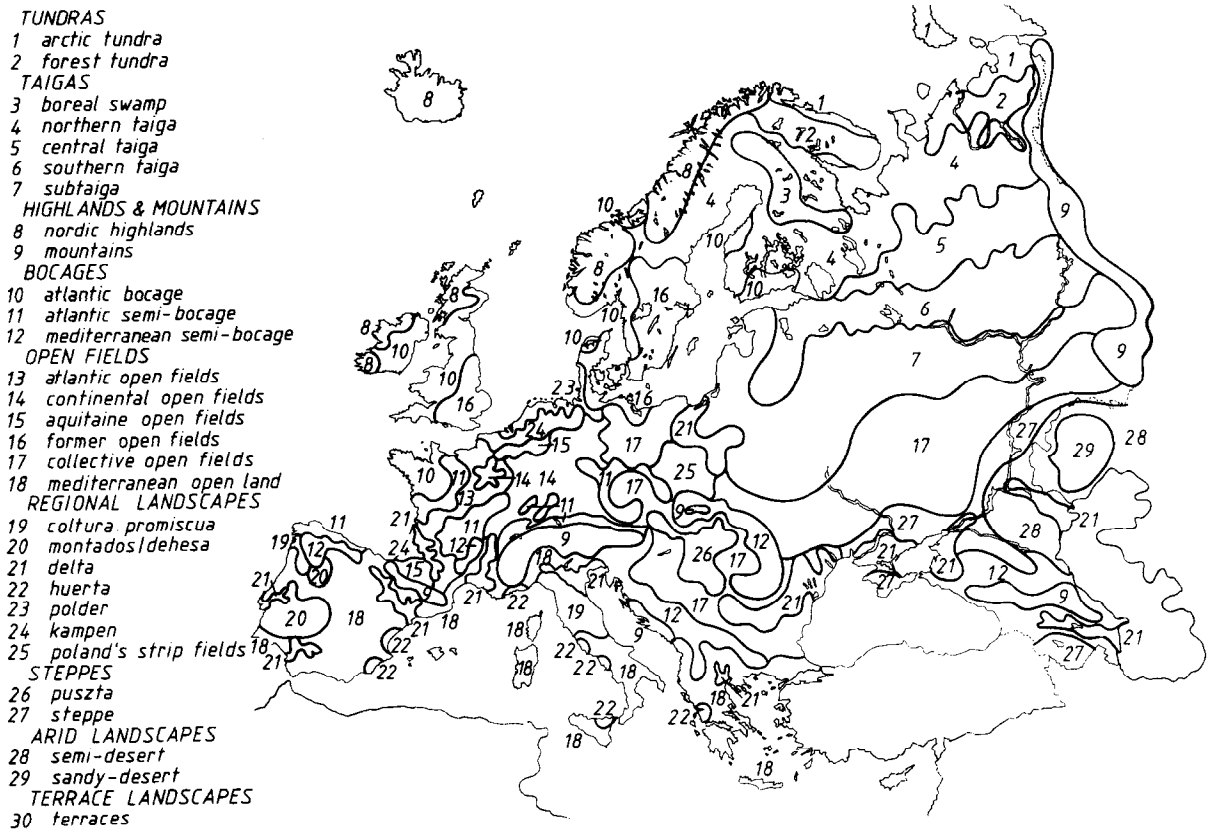


Fig. 3. Pan-European landscape types. After Meeus (1993).

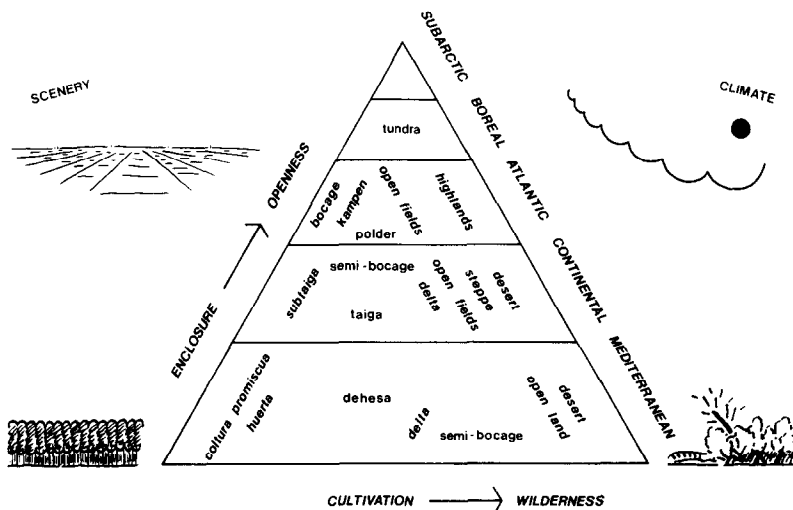


Fig. 4. Human cultivation creates different landscape types in relation to the climatic conditions. Each landscape has an unique relationship with the scenery (from enclosed to open) and more or less cultivated ecosystems.

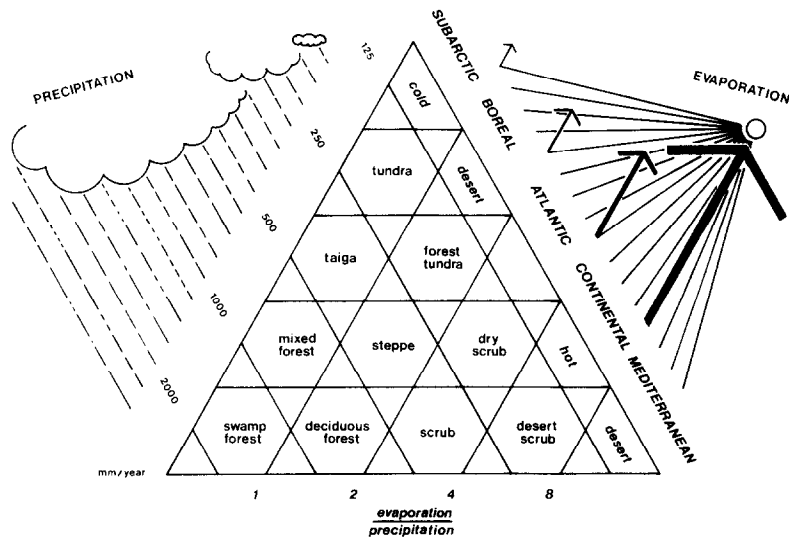


Fig. 5. The relationships between climate and potential vegetation when cultivation is neglected. After Goudriaan (1993).

gram (Fig. 5), it is possible to visualise the most important factors affecting the growing conditions of vegetation related to different 'natural' landscapes (Goudriaan, 1993). Growing conditions are based on the ability of plants to transform organic chemical elements with the aid of sunlight into biomass—the process known as photosynthesis. The sides of the triangular diagram represents different conditions of water availability controlled by the rates and levels of evaporation and precipitation. On the basis of this diagram, 12 main types of potential natural vegetation are located in a triangle, with the five climatic zones of Europe. Natural growing conditions will follow these climatological and biogeographic zones, but not all the combinations implied by this diagram may be found 'in the field'. The distribution of vegetation that might be found across Europe, if *Homo sapiens* had no influence (the potential natural vegetation) can be estimated (Noirfalise, 1987; Landscape Map of the USSR, 1988).

This diagram of potential vegetation is too schematic, because the human influence on the vegetation and the topography is neglected. To have an understanding of the actual European landscapes, the effects of human influence must now be added.

The human factor controls the degree of enclosure or openness of the landscape. This, combined with topography and the factors above, produces the 'scenery', a cultural expression of the landscape aspect. The pan-European landscape types are an expression of all these factors. The Holdridge diagram depicted in Fig. 4 combines climate, vegetation and landscape scenery, creating a field in which most of the different landscapes in Europe can be characterised.

4.7. Regional, zonal and typological landscapes

Each landscape can be described in two different ways. First of all by emphasising specific features of the individual elements and the relations between them, which makes one 'regional' landscape differ from another. Such regionally specific landscapes are non-repeatable in time and space such as for example, the bocages of Brittany. However, 'zonal' or 'typological' landscapes can be discerned by searching for the more general features of the components and relationships, which distinguish the given area from its surroundings, similar localities occurring repeatedly in space and time. Tundras, bocages and openfields in general are examples of these sort of landscapes.

The following distinction is made between 'zonal' landscapes conditioned by climate and potential natural vegetation. Moving from one climate zone to another, from Arctic and boreal zones to Mediterranean semi-arid areas, one can find tundras, taigas, steppic and arid landscapes. Generally speaking, in the northern and eastern part of Europe, landscapes continuously resemble potential natural conditions.

The degree of enclosure or openness is used to identify bocages on the one hand, and open fields on the other. The human factor controls the degree of closedness and openness of the landscape (Ihse, 1995). This, combined with topography and the factors above, produces the 'scenery', a cultural expression of landscape aspects. The landscapes in Europe vary from enclosed landscapes to open landscapes—bocages or enclosed landscapes with hedges on one side and open fields on the other.

Finally, typically 'regional' landscapes can be distinguished. In some parts of Europe specific regional landscapes came into being or remained unchanged, such as the open forest landscapes (montados or dehesa) on the Iberian peninsula, the coltura promiscua in Italy and Portugal and Poland's strip fields. Sometimes these regional landscapes are too small (less than 100 km × 100 km) to be located on a 1:25 000 000 map of Europe (Meeus, 1993).

4.8. *A descriptive assessment of European landscapes*

In this section a description is given of the growing conditions, vegetation, scenery and dynamics of the landscapes of northern, central and eastern Europe and a short summary of the landscapes in the European Community (Meeus et al., 1990).

4.8.1. *Tundras*

Tundras are naturally treeless, sparsely vegetated, inaccessible lowlands and valleys above the Arctic circle; with zones of transition to thin boreal forests. Apart from relatively small subzones two major landscapes can be distinguished: Arctic tundra and forest tundra.

4.8.1.1. Arctic tundra. The Arctic tundra is a desolate open landscape with glaciers and exposed rocks, covered with scattered patches of algae, mosses, grasses and lichens. This tundra can be found in a narrow band in northern Norway, expanding further east into Russia (Malozamelskaya and Bolshemeskaya Tundra). Tundra landscapes are influenced by 'permafrost' on gleysols. Many migrant birds (geese and ducks) and reindeer herds spend spring and summer in the arctic tundra. Most of the tundras are roadless. Animal husbandry, hunting, fishing and tourism are the only signs of human presence here. These areas are, nevertheless, very sensitive to the impact of human activities. The fragile ecosystems supported here can be easily damaged, a process which may produce irreversible changes: protection for these areas is therefore essential (Rosswall and Heal, 1975).

4.8.1.2. Forest tundra. Boreal forests are thin and open. There are no dense forests, only bare rocks. In river valleys, where the trees are protected against the severe climate, sparse forests can be found. This landscape is characteristic of areas far up north around the Arctic circle, like Lapland, the Kola Peninsula and the river valley of Pechora. Only dwarf shrubs and scattered trees (deformed birch and alder) can grow on unprotected sites. Sedges, rushes, grasses and mosses cover the waterlogged grounds of mires and swamps (Landscape Map of the USSR, 1988). Natural and climatic conditions are severe. Permafrost, low temperatures, poor sandy podzols and gleysols with a shortage of water in the summer periods and surpluses at other times, make the vegetation period short and intense (Rosswall and Heal, 1975). Most of the reindeer pastures are located in the forest tundra zone. Roads are scarce, making these tundras inaccessible for transport (Bernes, 1993). In boreal forests one- or two-species stands (larch, spruce, birch) are widespread. Although the commercial interests are low these forests are subjected to considerable changes because of the concentrated clear cuttings (A. Pisarenko, unpublished data, 1993). These cuttings are a severe threat since the erosion introduced this way obstructs

the natural regeneration of the secondary forest. Forest fires are a natural part of the dynamics of boreal forests. However, their occurrence has now turned into a factor of anthropogenic degradation. As a result of the fires, the reindeer pastures have become severely damaged in Russia. The most important features in forest tundra areas in need of protection are the fresh-water reserves which act as habitats for many animal species (A. Pisarenko, unpublished data, 1993).

4.8.2. *Taigas*

The coniferous forests (pine and spruce) of the boreal zone in Fenno-Scandinavia, Finland and northern Russia are called taigas. At high altitudes and under extremely wet conditions conifers make way for birch. The most homogeneous forests can be found in the northern taiga: hundreds of kilometres of conifer stands. On mid-latitudes further to the south, where the boreal climate becomes humid continental, the conifers are mixed with broad-leaved trees and there is some agricultural activity (southern taiga), while in the subtaiga zone, deciduous forests dominate the surrounding arable land.

4.8.2.1. Boreal swamp. Boreal swamps are wet, sparsely forested areas with an open scenery. Peatlands, with bogs and fens, they are the areas in the Nordic countries with the largest numbers of different species. They can be found in a belt from the southern part of Lapland to mid Finland and Karalskaya, Russia. Mixed swamp forests on peaty histosols are slowly degrading into a thin forest, where finally only sphagnum, grasses and mosses can grow. Forestation on wet sites used to be a widespread practice, especially in Finland. Because timber production is low, more than half of the original area of wet forests, bog and fens was drained in the 20th century. In Finland, birches are now being planted on a relatively large scale. The artificial drainage has displaced many wetland species. With the scale of drainage operations decreasing, the primary threat to the remaining fens is their tendency to be overgrown as a result of eutrophication (Bernes, 1993).

4.8.2.2. Northern taiga. The northern taiga is a semi-open coniferous forest in the hills and plains of the Nordic and the northern Russian region. The thickest forests are to be found in the river valleys and on the river terraces. The dominant trees are spruce, pine and birch, which give the northern taiga its appearance of uniformity and homogeneity (Landscape Map of the USSR, 1988; National Atlas of Sweden, 1990–1992). Lichens, mosses and berry-bearing shrubs cover the ground. There is a fine-meshed network of forest roads. Severe frost make the growing season short, while the mean annual temperature is low. There is an excess of water during the year, but because of a low water retaining capacity of the sandy podzols, there can be severe drought problems during the growing season. Only small-scale forestry and extensive grazing are possible. In the Nordic regions forest fires are successfully controlled. The forest trees are cut mainly to provide the local population with wood. Reindeer pastures can also be found. In Finland and Sweden in particular, many old wooded pastures and extensively used stands of birch and other deciduous trees have had to make way for conifer plantations (Bernes, 1993).

4.8.2.3. Central or middle taiga. The central or middle taiga is the most densely forested boreal landscape in the Russian part of the Northern European Plain. The narrow zone of coniferous forests near Petersburg-Leningrad is expanding into the eastern parts of Russia. Spruce, fir and pine may grow very tall, but birch, combined with pine and aspen, can be found in these areas too, where in the clear cutting process forest fires have removed the original woodland cover. The productivity of the middle taiga forest is essentially higher than that of its northern counterpart. The forests are divided by mires, bogs and swamps. Less than 10% of the area is used for (open) pastures, which makes the scenery extremely closed (Landscape Map of the USSR, 1988). The climate is less extreme than in the northern taiga but the growing season is too short and the sandy podzols are too poor to make arable cropping important. Extensive cattle raising and dairying is the only agricultural activity (Agricultural

Land Use Map of the USSR, 1991). The forests of the central taiga are subjected to intensive exploitation: timber is grown and collected on a large scale. Most of the forests are drained and many trees are felled by applying clear cutting methods, especially in the regions located near the lines of transportation. Apart from its economic importance the central taiga plays an essential role in environmental protection, increasing the absorption capacity of the soil, regulating the run-off and protecting the soil against the direct impact of wind and rain (Pisarenko, unpublished data, 1993).

4.8.2.4. Southern taiga. The southern taiga is a semi-open forest landscape, expanding in an easterly direction from the Gulf of Finland to the Ural Mountains. The climate is boreal to humid continental. Thin forests are combined with natural fodder lands and fields which cover approximately 10–20% of the area. In between the conifer forests, on sites where secondary birchwood scrub forests have been cleared, a growing agricultural area (mainly pastures but also arable land) can be found. Large tracts of swamp, bog and marsh occur on the poorly drained flatter areas above the river valleys. The forests consist of high quality stands of spruce, pine, birch and aspen which are exploited intensively, the sandy, silty and loamy soils (podzoluvisols, luvisols) providing excellent growing conditions for such forests. Agricultural production in the southern taiga requires artificial drainage and heavy fertilisation. There is a high proportion of non-developed marshland (Landscape Map of the USSR, 1988; Agricultural Land Use Map of the USSR, 1991).

4.8.2.5. Subtaiga. The combination of arable crops and forests, on fertile, lime rich and silty soils (podzoluvisols, luvisols and cambisols) in a gently sloping terrain is called 'subtaiga'. The Baltic countries, Belorussia and the central parts of Russia have these deciduous subtaiga forests.

The long history of human exploitation of the mixed broad-leaved forest has modified the character of the original forest into a semi-open landscape where more than 50% of the area is

ploughed (Landscape Map of the USSR, 1988). Because of the temperate continental climate in the subtaiga zone a much larger number of crops can be grown and the number and variety of cattle surpass those of the other taigas. Sugar beet, potatoes, grains, flax, maize and fodder are grown. Many large collective farms and compact villages have been created in the landscape, where there is a dense network of rural roads.

In the Baltic countries also fodder crops, such as potatoes and grain, are grown. Marshland and forestland are disappearing rapidly owing to drainage and deforestation (Agricultural Land Use Map of the USSR, 1991). The majority of roads and farms can be found between Moscow and Gorky. The expansion of the population in this region has resulted in the construction of more 'dachas' (holiday homes in the country), simultaneously stimulating the intensification of agriculture, particularly in dairy, pig and poultry farming and vegetable production (Symons, 1990).

4.8.3. Highlands and mountains or uplands

Uplands are marked on the one hand by the occurrence of high mountains with a strongly dissected topography and an alpine climate, and on the other by highlands on middle mountains in the temperate zone. Both are rocky, rough, desolate and wild.

4.8.3.1. Nordic and northern highlands. The highlands in the extreme north-western part of Europe are open landscapes, on a hilly and mountainous terrain. Found in the western parts of Ireland, Scotland, Iceland, the Faroes and western Scandinavia the highlands are usually typified as rough and desolate. Thanks to the Gulf Stream these areas have a much more favourable Atlantic or marine climate than other areas of similar latitude. There is a relatively high net precipitation during all months of the year. Owing mainly to overgrazing by sheep, most trees and bushes have disappeared, leaving only ground vegetation and bare rocks (Meeus et al., 1990; Bernes, 1993).

The highlands are characterised by stony and organic soils (leptosols, histosols) and a major

surplus of water; there is non-intensive agriculture. Bogs, fens, heath, bare rocks and subalpine birch dominate the landscape. Apart from extensive sheep farming, large-scale afforestation can be found in northwestern Scotland. Although large parts of the highlands have neither roads nor human occupation, the landscape looks the way it does as a result of human intervention. In Scotland and southwestern Scandinavia, forest clearance and overgrazing by sheep have resulted in the disappearance of trees and bushes. In Iceland, ground vegetation has also been lost, creating a severe erosion risk for the soil. It has been estimated that, to date, in Iceland half of the original soil and vegetation cover has been lost (Bernes, 1993). The sustainable use of natural resources combined with the importance of tourism, makes protection from overgrazing and prevention of erosion important issues in the highlands.

4.8.3.2. Mountains. The Pyrenees, Alps, Tatra, Caucasus and Ural Mountains are characterised by an alpine landscape with glaciers, bare rocks and steep slopes on the one hand, and forests, pastures and valleys on the other. There is a severe contrast between wild and rough areas and cultivated, enclosed versus open spaces. Arable land is mainly concentrated on the gentle slopes in the valleys, except for some extensively used grazing grounds. The lower slopes are either wooded or covered with meadows. The short growing season and thin, stony soils (leptosols) create an ecologically unstable system. Mountain farming has lowered the upper timberline by several hundreds of metres and overgrazing has stimulated the increase of rocky grounds. While overgrazing still plays an important role in southern Europe, mountain farming is on the decrease in central Europe. Farmers leave their mountain meadows because of production difficulties. Trees are planted to avoid erosion and landslides. In Switzerland and Austria steps are taken to preserve areas that are in danger of being abandoned. Meadowlands are cut to maintain open areas. Arrangements are made to preserve the landscape and maintain traditional farming habits (Bätzing, 1991). The mountains of the

Alps are densely populated and intensively cultivated. In many parts of the Alps the mountains have reached maximum ecological carrying capacity (Young, 1991). Climate, vegetation and land use in the Pyrenees are different. The valleys are smaller and there are few solitary farms. Agriculture is mainly limited to dairy and sheep farming, the former growing increasingly popular. In the Caucasus the cattle and sheep are herded up to the pastures every summer and brought down to the farms in the valleys in winter. As a result of deforestation, intrusion of domestic grazing animals and overuse by the people of the densely populated lowland areas, many mountainous species have become scarce (Symons, 1990). Agro-forestry, a combination or rotation of arable crops and forest (under strict control), holds promise for mountain regions but is still largely at the experimental stage (Driesen and Dudal, 1991).

4.8.4. Enclosed landscapes with hedges or bocages

Bocages are enclosed landscapes where the mosaic of small plots, surrounded by hedges, trees, forests or walls betrays the influence of a long history of intensive and extensive cultivation.

4.8.4.1. Atlantic bocage (Fig. 6). The bocage landscape is a classic example of an enclosed landscape: a mosaic of plots, each surrounded by a wall or hedge. Atlantic bocages can be found in Brittany, central England, Ireland and along the coast in Scandinavia. Soils are moderately fertile (luvisols, cambisols, gleysols) and, in an Atlantic climate, rainfall is abundant. The land is used intensively. Farmsteads are scattered and the network of rural roads is dense. Traditionally, this landscape has been dominated by mixed crops; now grasslands are becoming more important (Lebeau, 1969; Park, 1989). In Brittany many grasslands have recently been drained at deeper levels and been stripped of less functional plot demarcators such as hedges or trees, facilitating the use of larger agricultural machinery. Here the traditional system of mixed crops on small plots has been replaced by animal and fodder production on large-scale plots. The result of



Fig. 6. Bocage landscape in Dorchester, southwest England.

these changes includes increased run-off, erosion, and eutrophication of surface water and groundwater (Young, 1991). In Britain, extensification of the bocages has occurred in hilly areas. In Ireland, increasing numbers of cows are kept in the bocage landscapes and some plot enlargement is taking place, increasing the openness of the landscape (Meeus et al., 1990). Livestock rearing is concentrating in the semi-open mixed landscapes near the coast of the Nordic countries, where marginalisation and afforestation is taking place (Ihse, 1995). In northwest Denmark, new hedges are being planted to prevent wind and water erosion (Bernes, 1993).

4.8.4.2. Semi-bocage. A variation of the bocage landscape has fewer hedges, more walls, more fallow land and larger forests. These so-called semi-bocages are enclosed landscapes, to be found in the mountainous areas of the Massif Central (France), northern Spain (Cantabrian Mountains) and the middle mountains in the northern part of the Alps and central Europe (Vosges, Black Forest, Bohemian Massif, Carpathians, Dinaric Alps) (Wijermans and Meeus, 1991; Atlas of the Environment and Health of the Population of the CSFR, 1992). Not every plot is enclosed; large and small plots alternate in a steep terrain. There is a cool and wet (mountainous) climate with a surplus of water. Compact villages and solitary farms are found side by side and the density of roads is low. Land use is extensive (dairy farming and sheep) and

there are many woods. Meadows are often surrounded by walls or trees, but are sometimes in a state of decline because the land is being abandoned and reafforested (Csati, 1980; Tavernier, 1985).

4.8.4.3. Mediterranean semi-bocage. In the rain-shadow of the middle mountains, in the eastern part of the Massif Central (France), the north-western part of the Iberian Peninsula, the Balkan Mountains and the area north of the Caucasus Mountains, one finds dry and extensively cultivated semi-bocage landscapes in a hilly and mountainous terrain. The climate is mediterranean. The landscape is a mixture of open and enclosed areas; forests create some degree of enclosure and protect crops against dryness and erosion. Apart from the arable land (grain, maize or sunflowers), valleys, pastures, orchards, vineyards and forests can also be found on foothills and in valleys (Csati, 1980; Wijermans and Meeus, 1991). Where the mountains of the Caucasus meet the Black Sea, subtropical perennial crops (citrus fruits), tobacco, fruits and grapes are grown (Agricultural Land Use Map of the USSR, 1991). In these areas people live in small villages. Deforestation and overgrazing of the steep slopes make water erosion a severe problem. Abandonment of land and reafforestation with *Pinus* and *Eucalyptus* is a common practice in southern Europe.

4.8.5. Open fields

The extremely open landscape of wide undulating plains with regular plots of arable land on fertile soil, is called 'open field'. The open fields are the granaries of Europe. A wide belt of open fields is extending from central Spain, across France, Germany and large parts of central and southern Europe into the vast chernozem belt of the former USSR. Six sub-types may be discerned: Atlantic, continental, Aquitaine, former and collective open fields and Mediterranean open land.

4.8.5.1. Atlantic open fields. In central France Atlantic open fields can be found, characterised

by high levels of openness. The farms are concentrated in villages; road density is low. Some occasional woodland relics can be found. Fertile loamy and clayey soils (cambisols) a temperate marine climate and the availability of water keep production levels high. Grain and rootcrops are grown (Tavernier, 1985). Large holdings, intensive crop farming, high levels of mechanisation and large-scale use of fertilisers and pesticides have created large monocultures (Thiébaud, 1993). In the past centuries several crops were grown. Because the farmers are reacting to the ups and downs of the world market, cereals are dominating the scene at the moment. Recent land consolidation has contributed to the openness and the increase in scale of the open fields. In the vicinity of large concentrations of people, where recreation draws heavily on the countryside, attempts are being made to make the landscape friendlier for people spending their spare time, by planting trees and creating different types of forests.

4.8.5.2. Continental open fields. While the general trend in open field areas is towards intensification of agriculture, creating an extreme openness of the landscape, the continental open fields in Germany contain more forests and pastures and less large-scale arable land, thus giving the landscape a slightly more diversified look (Wijermans and Meeus, 1991). This diversity in agriculture and scenery, is caused by differences both in the soil (clay, loam, loess in cambisols and luvisols) and elevation (Tavernier, 1985). Large parts of the continental open fields are not suited for the growing of cereals and root crops. In Germany, but also in the region of Ile de France, forests are found on the tops of the hills, while in the Atlantic open fields forests and woods are mostly located in valleys. In the continental open fields there is also some dispersion of farms along the roads. Steep slopes require afforestation or erosion control measures, since water erosion is a serious threat.

4.8.5.3. Aquitaine open fields (Fig. 7). A third sub-type of open fields is to be found on 'outwash plains' around terminal moraines at the foot

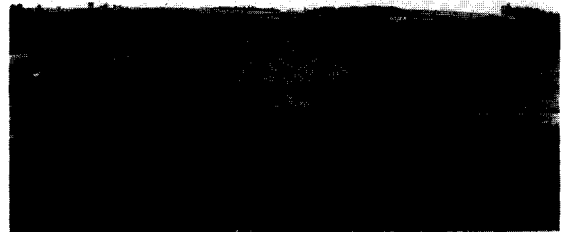


Fig. 7. Aquitaine open fields in Gascogne, southern France.

of mountainous areas like the Ardennes, the Pyrenees and Sauerland (Lebeau, 1969). At these locations a mosaic of plots can be found in an open scenery and a great variety of crops are grown. On the cambisols and luvisols (lime, loam and loess) situated on plateaus, cut by rivers and streams, intensive forms of agriculture (e.g. fruit orchards) are practised (Tavernier, 1985). Farms are not limited to villages only. In some parts, where slopes are steep, meadows, orchards and forests are found in the valleys and crop farming is practised on the plateaus. Aquitaine open fields are sensitive to land slides and water erosion.

4.8.5.4. Former open fields. Former open fields are hybrid semi-open landscapes on hilly terrain. Scattered buildings and fragmentation of land parcels characterise the former open fields (Meeus et al., 1990). Smaller areas, poorer soils (podzols, cambisols, gleysols) and a lower intensity of farming provide opportunities for both cropping and livestock breeding. The historical development of these landscapes differs from the open fields mentioned above. On the less fertile sandy and gley soils there is a deficiency of water for cereals and root crops during the growing season. The production capacity of these crops is remarkably lower, compared with the Atlantic open fields. Cereal cultivation alternates with livestock farming. Remains of hedges and trees can still be found in southeastern England (Bowers and O'Riordon, 1991) and western Denmark

(Bernes, 1993), while in eastern Denmark and in the open plains of southern Sweden, bushes and tree-rows and have been removed during the last 50 years (Primdahl, 1991; Ihse, 1995) to such an extent that these areas are going to look like Atlantic open fields, although the plots remain smaller and the settlements are dispersed. At the moment there is increasingly less arable land, which is concentrated in smaller areas, mixed farming is disappearing and marginal lands are set aside or reafforested. The result is a more homogeneous and open landscape.

4.8.5.5. Collective open fields. Two subtypes of collective open fields can be found, one in the central and one in the Russian part of Europe. The growing conditions are different.

(1) In most central European countries traditional subsistence agriculture has been substituted, since 1945, by intensive industry on 'collective' farms (Kostrowicki, 1984). This is particularly true for the belt of loam and loess (luvisols) in central Europe, from Germany, the Czech and the Slovak Republic eastwards to Ukraine and further southwards to Rumania and the Black Sea which has been almost entirely transformed into so-called 'central collective open fields': a large-scale, almost treeless, open landscape on undulating plains, intensively used for arable crops, with a large-scale network of rural roads and collective farms (Lipsky, 1995). The belt of open fields is situated in a continental climate zone (cold winters, hot summers).

(2) The fertile chernozem belt in the southern part of Russia was originally covered with wooded steppes and grasses. In the 20th century the fertile chernozem soil has been cultivated by the establishment of collective farms and transformed into so-called 'eastern collective open fields': treeless, arable land divided into large plots on flat to undulating plains, creating an open and very dry landscape. The chernozem belt is situated in a continental climate zone, where annual precipitation equals annual evaporation (Driessen and Dudal, 1991).

Up to 75–95% of the areas with collective open fields in the Czech Republic is ploughed for arable use (Atlas of the Environment and Health of

the Population of the CSFR, 1992; Csati, 1980). Activities like tilling, sowing, applying fertilisers and pesticides and harvesting have become increasingly mechanised. Wind and water erosion are serious hazards. The Russian chernozems are very fertile. They have a thick layer of loess containing large amounts of black humus, hence the name 'black earth'. The majority of the large farms combine the large-scale growing of grain with breeding of livestock. There is a wide network of rural roads. Pastures are found in moist lowlands, in river valleys and among the scarce mixed forests. Maize and sugar beets are grown as well, while sometimes specialised crops like fruits or hop are also grown (Symons, 1990). Up to 80% of areas with collective open fields in Ukraine and southern Russia are ploughed for arable use (Csati, 1980; Agricultural Land Use Map of the USSR, 1991).

4.8.5.6. Mediterranean open land. Mediterranean open lands are the hotter and drier versions of the Atlantic open fields, characterised by a sharp contrast between the openness of the cultivated and the wilderness of the uncultivated areas. They are found in the Spanish highlands, the mountain regions of northern and southern Italy, Albania, Greece and the European part of Turkey (Csati, 1980). Cereals are grown on a large scale here and wherever possible, olive trees cover the hillsides. Higher up, the mountains are used for extensive grazing, with drovers' roads between the lowlands and uplands. Because of the hot climate, a sometimes poor and stony soil (cambisols, luvisols) and, not least the lack of water in the growing season, yields are low. The soil is difficult to work and erosion risks are moderate to high (Corine, 1992). Arable land is intersected by shrubland and wetland. Desertification is one of the results of human over-exploitation in the steppic areas of the plateaux and the depressions of the Iberian peninsula. However, there are small areas, with so-called 'coltura promiscua'. Here traditional integration of human activities and natural environment has created a heterogeneous landscape with a mosaic

of different land use forms. These small areas are intensively cultivated, a practice based on a non-specialised rural culture that respects natural values.

4.8.6. Regional landscapes

Regional landscapes are the answer of cultivation to specific local and regional conditions of landform, soil, climate or habitation. The sustainable integration of human activities into the natural environment has created several heterogeneous landscapes. These landscapes are sometimes too small to be located on the map of Europe but there are for example large areas with a mosaic of mixed agriculture and agro-sylvo pastoral systems in open forests. In 'artificial' landscapes like polders, huertas or terraces, man has taken over the landscape forming process almost completely.

4.8.6.1. *Coltura promiscua*. The *coltura promiscua* is an enclosed landscape, characterised by intensive traditional mixed farming. The landscape displays a classic 'upright' pattern of trees, bushes and ground cover. Examples can be found in central Italy and on valleys in the Iberian peninsula. In the foothills of the Apennines, *coltura promiscua* is combined with terraces (Lebeau, 1969). These retain both the scarce rainwater and keep the thin layer of soil in its place. Scattered farmsteads can be found, and the population is concentrated in villages. In Spain there are several small areas with a mosaic of traditional land use forms in between the Mediterranean open land. The traditional mixed cultivation of the *coltura promiscua* in central Italy and northern Portugal is strongly affected by the present tendencies in agricultural management. These traditional agricultural landscapes will therefore most probably disappear when the choice is between intensification or marginalisation (Meeus et al., 1990).

4.8.6.2. *Montados/dehesa* (Fig. 8). The *montados/dehesa* is a savanna or grazed thin forest landscape. Orchards are found with well-spaced trees. Although much of the scenery is enclosed, some of it is open. This type of landscape is called



Fig. 8. *Montados/dehesa*, Salamanca, western Spain.

'*montados*' in the southwestern part of the Iberian peninsula, Alentejo (Portugal), and '*dehesa*' in Extremadura (Spain). Oak, cork oak, or olive trees provide shade to grazing animals, pigs, sheep or cows, and prevent the soil from drying out and erosion. Dryness and low fertility of the soil (luvisols) are severe problems. There is a delicate equilibrium of a multiple-source, low-input agriculture with a high level of self-sufficiency. A form of traditional, low-input, extensive agriculture has been practised here for many centuries. However, these areas are now faced with a choice between intensification (cultivation of grain) or marginalisation (forestry). In both case the trees are considered to be a troublesome obstacle. From a cultural heritage point of view, this agro-sylvo pastoral system is considered highly valuable (Balabanian, 1980).

4.8.6.3. *Delta*. Deltas are open and flat landscapes near rivers and outwash plains of mountainous areas. In Spain the term '*mesa*' is used for the delta areas, which include the sloping transition zone to the surrounding hills and plateaus. Along the main rivers in central, eastern and southern Europe these areas are intensively cultivated (Kostrowicki, 1984). Deltas can be found along the River Rhone in France, the Po in Italy, the Ebro in Spain, the Tagus in Portugal (Corine, 1992), the Danube, Don and Volga in Russia (Symons, 1990; Agricultural Land Use Map of the USSR, 1991) and the Vistula in Poland (Csati, 1980). Deltas are open landscapes

with rural and urban concentrations. The continental and mediterranean climate in the deltas is warm and dry, which calls for artificial drainage and irrigation of the fertile soils (luvisols, fluvisols, kastanozems) to get the best yields. Deficiency of water for the crops makes salinisation of the soil and pollution of the water the most serious hazards in the delta areas. Openness dominates the landscape and intensive cultivation dominates its use (arable and horticultural crops). Deltas are more or less comparable to the polders in northwestern Europe (see below). As a consequence of drainage and irrigation the layout of the land is quite regular, while the land is allocated in a rational manner. Patterns of rectangular fields alternate in form and orientation. They are sometimes crossed by the tributaries of old rivers and river woodlands (e.g. poplars). The straight lines of drainage ditches or irrigation canals contrast with the surrounding river floodplains and saline wetlands.

4.8.6.4. Huerta. Along the coasts of the Mediterranean Sea, for instance near Valencia in Spain, compact, intensively cultivated agricultural regions are found, called 'huertas' (Lebeau, 1969). Irrigation allows for intensive agriculture and orchards add an enclosed look to the scenery. The land is intersected by irrigation ditches and is often terraced. Many types of fruits, citrus fruits and vegetables are grown (Csati, 1980). The huertas are expanding, especially in France and Spain, where large irrigation projects have been realised.

4.8.6.5. Polder. The flat and open landscapes in the lowlands of northwestern Europe are called 'polders'. Polders can be found in the western part of the Netherlands, the northern part of Germany and in southwest Denmark. An Atlantic climate means that rainfall is abundant. Artificial drainage, regular fields, scattered farmyards and relatively large farming units, make these landscapes very flexible. Fertile soil (fluvisols, cambisols), modern land division and management aimed at efficient production warrant high levels of output. In contrast, the polders with their peaty soils are characterised by a

backward agricultural structure and a rich natural potential. The areas along the coast, rivers and estuaries, and the low-moorland areas are particularly important for fauna and flora. Wet grasslands provide habitats for wild species of plants and animals, such as meadow and migratory birds. These areas are ideal for water recreation and nature development. The polders with their clay soils have regular fields and large farming units. Because the soil is fertile and deeply drained these polders can be used efficiently for growing crops and raising cattle and for planting broad-leaved trees (Atlas Van Nederland, 1984–1990).

4.8.6.6. Kampen. Found in Flanders (Belgium), the southern and eastern parts of the Netherlands, in North Rhine–Westphalia (Germany) and also in Les Landes (France), the 'kampen' landscapes are generally enclosed, with a patchwork layout of woods, heath, swamps, mixed crops, scattered farmsteads and roads (Wijermans and Meeus, 1991). There is a great diversity of trees on plots and the poor sandy soils (podzols) are cut by stream valleys. This rich diversity of the kampen landscape makes it highly flexible for the growing of crops. There are some interesting ecological differences between cultivated land on the one hand and heath and wet pasture land on the other. The poorest soils are covered with woods. Intensification of agriculture, abundant use of fertilisers and manure and fragmentation of wildlife habitats have made the contrast between the open areas and the enclosed farmland almost disappear in the Dutch kampen. The quality of the kampen is under pressure because of the vulnerability of the ecological system. Nature areas are split up, vegetation is being removed and there is the threat of soils drying up and groundwater becoming polluted. Increasing numbers of cows and pigs per hectare means large quantities of manure for disposal. There is also an abundant use of nutrients and pesticides. The carrying capacity of the sandy soil compares unfavourably with its clay and peat counterparts. The sandy soils of the kampen landscape are therefore particularly threatened by groundwater pollution because of these activities. Drainage is also changing the wet grass-

lands, heath and marshlands and makes them lose their natural character (Atlas Van Nederland, 1984–1990).

4.8.6.7. Poland's strip fields. In the eastern part of Poland, traditional labour-intensive agriculture has outlasted collectivism. Since the 1980s private agriculture on extremely small plots has been changing into modern market-oriented agriculture and part-time farming (Kostrowicki, 1984). This landscape has a long-standing historical connotation. The parcels are split up into a pattern of strips, buildings are concentrated in compact villages and there is a small-scale network of rural roads (Verhoeve and Vervloet, 1992). Mixed crops, orchards, horticulture and the presence of many people and horses on the small plots gives this landscape a scenery with an 'allotment garden' touch.

4.8.7. Steppic and arid landscapes

Steppic and arid landscapes are almost completely treeless, very open and extremely dry. Steppes have an annual rainfall of less than 400 mm; more than twice the quantity that falls in deserts (200 mm) where the rainfall is not enough to support vegetation.

4.8.7.1. Puszta. The word 'puszta' probably stems from the languages of the Carpathian-basin peoples. It is a Slavic word, originally depicting a land of non-profitable agricultural use, or cultivation to be more specific. In general, it implies land without trees with a poor soil, mainly on the Great Hungarian Plain and to a smaller extent on the hilly areas of Transdanubia. Today, puszta means grassland on salt-affected soil or on sandy soils, like the sandy soil between the Danube and Tisza Rivers. In Hungarian scientific descriptions a distinction is made between the so-called saline (natron) puszta and the sand puszta.

On the loess plateaux of the Hungarian plain, climate and vegetation are of a steppic nature. Chernozem dominate the scene and the landscape is open. Only in the valleys are there some trees left, the main vegetation being grass. There are large plots of agricultural land. Farms are concentrated and sometimes collective (Csati,

1980; Kostrowicki, 1984). Because of dryness during the summer the fertile chernozems and phaeozems (reddish prairie soils) are mainly used for livestock breeding but arable crops may be grown as well. Highly mechanised and productive agricultural systems are separated from those which are less intensive. The most serious hazards are wind and water erosion. As a consequence of deforestation carried out over the years, all the puszta areas of the Great Hungarian Plain are covered by a secondary vegetation of grassland which distinguishes them from the eastern European and Russian steppe areas.

4.8.7.2. Steppe. Steppes are by definition open and treeless landscapes. On the flat to undulating plains between the hills of central Russia and the Black and Caspian Seas there is an east–west oriented belt of steppes (Landscape Map of the USSR, 1988). With an average annual rainfall of 400 mm, a dry, warm and windy climate, only ephemeral grasses can cover the ground. In valleys some isolated groves of oak and some salt marshes are left, on solonetz. The soil contains fertile loess deposits and is rich in humus. The top soil has a dark-brown colour, hence the name: brown earth, dark-chestnut soil or kastanozem. For a long period of time, the ground had been covered with drought-resistant feather grass, sedges and herbs. Now, pasturing is sometimes too intensive and most of the grazing land has been degraded. The remaining steppes are confined to territories with a relatively low presence of pastures (Zalibekov, 1992). Periodic lack of moisture due to summer heat and strong dry winds keeps the agricultural yields of grass and grain below the extremely high yields of the chernozems in the collective open fields. During the late 1950s and early 1960s shelterbelts of drought-resistant trees were planted, the deltas of the main rivers Dnepr, Don, Kuban and Volga were irrigated and the so-called 'virgin lands' of the steppes were cultivated. Now, more than 50% of the fields are ploughed and sown with wheat or other cereals and there is intensive livestock breeding (Symons, 1990). There are some problems with the sustainability of the steppe landscape. Care must be taken to avoid salinisation

on irrigated kastonozems (Driessen and Dudal, 1991). Dehumification of the soil and pollution of the water can lead to a decrease in productivity (Zalibekov, 1992).

4.8.7.3. Semi-desert. The northwestern part of the lowlands near the Caspian Sea is a transitional zone, as is shown by a vegetation combining species of both steppe and desert. It is called semi-desert (Landscape Map of the USSR, 1988). The sparse, open vegetation of steppe grasses is mixed with drought-resistant dwarf shrubs and ephemeral plants, which grow during the extremely short rainy season (Symons, 1990). Especially in depressions with solonetz and solonchaks soils, salt-marsh and halophytic vegetation can be found. Aridity, dryness and deep water tables are responsible for salinisation and alkalinisation of the soil. Apart from the salinated solonchaks there are the calcisols, with their top-soil concentrations of calcium carbonate. The organic matter content of the surface of calcisols is low because of the sparse vegetation and rapid decomposition of vegetable debris (Driessen and Dudal, 1991).

Sheep and cattle herds may graze in spring and autumn, but only where grazing remains extensive. The increase of anthropogenic influence and the lowering of the water table are the factors responsible for desertification of the meadow-steppe. The Caspian Sea has been subjected to sea level variations which may partially be caused by changes in the discharge volume of the Volga. Water levels continued to fall until 1977, but since have been rising by an average of 10 cm year⁻¹. This sea level rise causes problems for beaches and cities in the north Caucasus region but also creates challenges owing to the expansion of flood territories and the rising of water tables. The degree of salinisation and swamping but also the length of the flood periods are indicators of the productivity of the ecosystems (Zalibekov, 1992).

4.8.7.4. Sandy desert. On the eastern side of the lower Volga, where Europe and Asia meet (Kazakhstan), there is a true desert consisting of shifting and drifting sands (Landscape map of

the USSR, 1988). There is not enough rain to support a vegetation cover which might protect the land from erosion. This is the prototype of a desert, with endless seas of sand, mobile dunes, deep and mostly dry river valleys and the absence of trees or other vegetation. Because of very hot summers, cold winters and a severe moisture deficit only drought-evading ephemeral plants can grow in these unstable sands during the very short vegetation period which follows the spring rains.

The more stabilised sands have a vegetation cover with some sedges, grasses, woody perennial plants and ephemeral sagebrush. These plants have a large root system and give some shelter from the heat to the scarce wildlife of e.g. reptiles. In spring there is a possibility for small-scale pastoral husbandry (sheep). The ecosystems are sensitive to overgrazing, while there is a threat of further dehumification and salinisation of the soil. The main function of desert landscapes is protection of the environment (Zalibekov, 1992).

4.8.8. Terrace landscapes

4.8.8.1. Terraces (Fig. 9). Terrace landscapes cannot be characterised by the vegetation or degree of openness of the scenery. It is a completely artificial landscape, where topography, soil and drainage system of the hilly terrain is reshaped by man. The hills with their (wine) terraces are a very special sort of landscape (Ambroise et al.,



Fig. 9. Terrace landscape in the Duoro valley (Portugal).

1989). This is an area of very intensive cultivation, literally adjusted to the demands of technology and the market. Old, narrow terraces are left and 'parked' as it were, some olive trees protecting them against erosion. If the market for this special product happens to grow, new terraces will be made. Otherwise, entire terrace hills may be left by people trying their luck somewhere else. It is obvious that this does not go unnoticed. This kind of landscape must be watched carefully when people start leaving. Otherwise the earth with its terrace walls and trees will come sliding down. Terrace landscapes, which do not have a fixed place in the field, cannot be located on the map of Europe.

5. Discussion

European landscapes are heterogeneous and complex owing to the differences in ecology and economy. These in turn create different regional landscapes, local habitats and biotopes. The close interaction between nature and man is reflected in the manner in which each European landscape has somehow been shaped by human activity. A man-made environment is a 'cultural landscape', rather than untouched 'nature'. Most of the time the landscape is a combination of natural and agricultural ecosystems and architectural elements, controlled by man. The patterns and processes taking place in natural environments are transformed to fit productive goals. Farming and forestry are responsible for the actual scenery of many landscapes, which most Europeans are accustomed to, and if the land use changes significantly (for instance when agricultural land is abandoned or afforested, to prevent overproduction or to make more 'wilderness') this might change the landscape considerably. The results of the two major tendencies in European land use—intensification and marginalisation—are a short-term loss of ecological diversity which may in turn not only threaten the diversity in wildlife but also the quality of land and water. In the long run the heterogeneity of the landscape and the quality of the scenery may be at risk as well.

The paradox of landscape conservation is that we may value the landscapes which we have inherited from the past, while they are merely the reflection of former patterns of land use and economic activity. Landscape conservation would therefore involve the unrealistic aim of preserving past economic patterns. Because this policy is impossible and unacceptable, landscape conservation, management and development should be integrated. This calls for policies designed to manage the process of change so as to reduce the damaging effects on the landscape and the natural and cultural resources it contains, and policies to encourage the creation of new landscapes.

Not only the landscapes themselves are in need of management, but this is also true for the transformation processes, which must be carefully controlled, planned and managed. Unfortunately, the processes of change in time and space are not that well-known. The changes themselves and the processes which lead to changes in the landscape need to be known, monitored, evaluated and if necessary controlled by public regulations. The processes of change need particular attention. When bringing about transformations, landscape and environmental considerations should be a major priority promoting environmentally conscious practices in agriculture and forestry. This is the only way to keep unwanted side-effects from the change itself and from the process bringing about this change.

Policies for nature conservation and landscape management should be combined with policies for taking land out of production and for expanding woods. Traditional land use systems, like the agro-sylvo pastoral system of the montados/dehesa and the Scandinavian grazed deciduous woodland may become a source of inspiration for extensive management practices, a basis for the integral planning of rural areas. One of the challenges to landscape management is to keep the cultural heritage alive by preserving not only the virgin forests and threatened biotopes or species but also the (agri-) cultural landscapes created by previous generations.

6. Conclusions

The environments described in this report are comprehensive continental landscape types, which may take on different regional forms. Since it is impossible to express all specific European landscapes on a map of scale 1:25 000 000 the results presented here are illustrative of general patterns, and do not attempt to describe all regional landscapes. Nor do they aim to present local details.

In conclusion, there are two major groups of problems involving landscapes, one group covers the problems of space and the other group involves the notion of time.

The first group of problems deals with the decline of landscape heterogeneity in large parts of Europe. This is not only a problem of biological diversity, preservation of habitats and species but also one which is intimately linked up with scenery, aesthetics and attractiveness of the landscape.

The second group of problems concerns knock-on environmental effects of badly managed or unplanned changes on landscapes (e.g. for economic or social reasons) resulting, for example, in erosion and water pollution. To solve these problems an integrated approach is needed for sustainable development in rural areas, to ensure long-term effectiveness of the ecological, economic and aesthetic aspects of the landscape.

In eastern Europe, where the influence of natural conditions is overwhelming, the landscape types follow the climate and soil zones closely. In western and central Europe the variation of landscapes seems to be larger in time and space, owing to different natural and historical circumstances. In central Europe (for example in the Czech Republic, Austria, Hungary and Slovakia) there are relatively small places where open fields can be found surrounded by terraces, intensively irrigated deltas and wetlands, semi-bocage and forests on mountains. In southern Europe, under a Mediterranean climate the landscapes reflect the ingenuity and age-long struggle of people to earn a living from the land in poor natural growing conditions: terracing, irrigation and low-input agriculture are the meth-

ods used, having altered the landscape accordingly.

In fact, there can be large landscape differences in one particular place. However, the same landscape type can may cover areas of hundreds of kilometres in size.

In general, European landscapes are becoming more uniform and homogeneous while some landscape types seem to disappear completely. Montados/dehesa, coltura promiscua, bocage and kampen are among the landscapes losing their distinctive features. Upland, taiga and even tundra landscapes are changing because they are no longer used for extensive agriculture and forestry. There is a need for better erosion control in the open fields, especially on loamy soils. Parts of the irrigated deltas are threatened by salinisation and pollution of water and soil.

Europe's landscapes represent a rich heritage of natural and cultural values. This natural and cultural heritage is under serious threat. Everywhere, the forces of change are putting pressure on those landscapes, with a resulting loss of heterogeneity and sometimes even more general degradation. The fragility and sustainability of landscapes becomes a serious issue. Landscape conservation must be complemented by policies which address major factors of landscape change. The landscape should be treated as an environmental resource and an integrating factor in the process of sustainable development. This calls for a landscape-wide approach, focusing not only on the loss of biodiversity and cultural elements in the landscape, but also on the need to create a more viable economic future for rural communities inspiring them to care for the landscape in which they live, and to bring about environmentally sensitive changes in it. This in turn calls for a framework of national and international support which identifies the European interest in the future of Europe's landscapes.

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