The Origins of Landscape Science

Definition of Landscape
The definition of the term ‘landscape’ by e.g. geographers, ecologists and others can be quite variable. The original meaning was probably connected to a visual view of surroundings, as a picture or scenery, as has been widely adopted in art and literature. As a scientific term, landscape was introduced only in the early 19th century by Alexander von Humboldt, who defined it as ‘the character of an Earth region’ that is more than just the sum of its parts, as was indicated by a German biogeographer Carl Troll (1939). According to the European Landscape Convention (2000), landscape means an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors. Landscape can also be regarded as a provider of resources that includes land use, natural capital, etc., as a way of communicating through social order or customary law, or as a research object. This definition is close to the ideas developed by a Finnish geographer Johannes Gabriel Granö who combined natural and cultural themes including perception of landscapes through sight as well as other human senses (Granö, 1929). Thus, landscape includes two components tied to each other: one is objective, real and visible landscape (e.g. landform, vegetation pattern and texture, water bodies, buildings, human infrastructure) and the other is the subjective, virtual, non-visible landscape (Palang, 1994) including feelings generated by senses, a knowledge and past experience of the place, cultural associations, etc. Landscapes are heterogeneous in at least one factor of interest (Turner et al., 2001) and therefore landscape types and sub-types having similar features or attributes can be defined.

Elements and Components of the Landscape
The state of landscapes is mainly determined by the mixture of habitats or land cover types resulting from many causes, including variability in abiotic conditions (geology, relief, soils, climate, water), biotic interactions of fauna and flora that generate spatial patterns even under homogeneous environmental conditions, patterns of human settlement and land use and the dynamics of natural disturbance and succession (Turner et al., 2001). The socio-economic factors determining the state of landscapes include the economy, for example production and distribution of goods and services, political factors such as objectives and decisions, social factors determined by the population and tourism and cultural factors such as traditions and values (Messerli and Messerli, 1978). Socio-economic factors are driven by political means e.g. agricultural, forestry and energy policy, land use planning, environmental protection and promotion of the economy, and by the demand for natural resources, recreational areas and other ecosystem services.

The dominant vegetation type, i.e. forests, arable lands, wetlands, meadows, is usually recognised as the main factor characterising a specific landscape. The dominant
The Rural Landscape

vegetation establishes the resource base for the rest of the ecosystem (Turner et al., 2001). The natural vegetation structure is in turn determined by the soil types that are decisive for land use, e.g. forestry or agriculture. Some soils, for example loess, can be more suitable for today’s agriculture. Therefore, the share of arable land in some regions of the Baltic Sea Region (BSR), e.g. in the south of Poland and in some areas in Germany, is very high. Other areas may need drainage or irrigation to be good for crop production. During the history of cropping, preferences with regard to soil quality have changed greatly depending mostly on the development of suitable agricultural technology, although the need for feeding people drove the modernisation of technology at the same time. For example, the earliest agricultural areas in thin calcareous soils in the north of Estonia lost most of their value for cultivation during recent millennia. In areas dominated by igneous rocks, as in most of Sweden and Finland and partly in north-west Russia, less fertile thin till soils prevail, so conditions for cultivation are poor and forest landscapes dominate. Similarly, sandy soils are generally of low fertility and too dry, and therefore rather unsuitable for agriculture. Interactions of climate, topography and soils have defined the vegetation zones in the Baltic Sea region, with boreal forests in the north and nemoral vegetation in Poland, Germany, Denmark, Belarus and partly Lithuania, and with a boreo-nemoral vegetation belt between these two zones (See Figure 1.3). Most wetlands in the Baltic Sea region are remnants of the post-glaciation period. Post-glacial land uplift and the eutrophication caused by nutrient enrichment have reduced many lakes to wetlands, while drainage programmes have reduced the area of marshland to a minimum, especially in Germany, Denmark and southern Sweden. Fortunately the area of wetlands in the north and east of Europe is still relatively high due to the lower population density and land use pressure.

Status of the Landscape

Depending on the degree of human interaction, landscape characteristics can be dominated by natural conditions or by human involvement. Thus a distinction can be made between natural landscapes and cultural landscapes and those that are somewhere between, i.e. semi-natural landscapes. We know that even habitats in remote areas (forests, mountains) have been somehow utilised or impacted and in Europe only a very few pristine ‘natural landscapes’ remain. In his classic definition, Carl Sauer (1925) describes the cultural landscapes as being fashioned from a natural landscape by a cultural group, i.e. the activities of man having imprints as rural, recreational and urban landscapes. Landscapes in the wilderness as well as landscape types that are far from natural conditions and that can be maintained only by permanent human involvement can be highly valued. This assessment can be based on ecosystem approach, on aesthetic, cultural, scientific or intrinsic landscape values, etc. Typical examples of landscapes that need permanent human involvement are alvar areas and wooded meadows that are nowadays in danger of being
The Rural Landscape

overgrown by bushes and trees, as well as the specific spruce fence landscapes in Sweden and Finland.

Traditional extensive farming practices are usually associated with the highest biodiversity, but higher concentrations of species of particular conservation interest can also occur in more intensively farmed areas. Areas where farming practices are associated with high biodiversity value are commonly referred to as High Nature Value (HNV) farming systems, where biodiversity conservation should be integrated into agri-environmental measures. The HNV concept, which first emerged in 1993, recognises the causality between certain types of farming activity and ‘natural values’ (Baldock et al., 1993). The HNV areas are typically low intensity, low input systems, frequently with high structural diversity. These landscape types can be highly valued even though they are far from natural conditions and can be maintained only by permanent human involvement, e.g. wooded meadows or other types of semi-natural vegetation that developed in conditions of low intensive agriculture or other types of semi-natural vegetation. The more recent concept of Traditional Agricultural Landscape (TAL) describes landscapes where intensive farming may have eliminated much of the natural value, while maintaining the most important traditional landscape features at the same time. In TAL the existence of high aesthetic and cultural values and ecological integrity are maintained using traditional management approaches.

Long-term History of Landscape and Land Use

Dynamics of Landscape Change

Landscapes are dynamic, both in time and in space. Today’s landscape changes and processes that are either natural in origin or carried out by humans take place simultaneously and are associated with fragmentation of both natural and semi-natural habitats. These changes will lead to reformation of the habitat area and habitat quality.

It is very likely that before the development of the traditional agricultural landscapes, the natural landscapes formed a mosaic of different forest types and open patches. This means that otherwise homogeneous land cover types represented a variety of patches in different successional phases. The landscape mosaic that we can see nowadays describes the changes in natural conditions and human pressures over a long period when both expansion and contraction of cultivated area took place (Figure 1.2) accompanied by similar changes in the area and composition of natural landscapes. We can even conclude that new socio-economic formation tries to create its own landscape based on new ideologies and by changing the uses and values of previous landscapes (Cosgrove, 1998). In most part of the Baltic Sea region, the human impact has been the main driving force in shaping landscapes, especially during the past centuries. These landscapes are in one way or another man-made.

The Glaciation Formed the Landscape

The general shape of landscapes in northern Europe originates from the last Ice Age and the post-glacial history, reshaped by the human impact that is visible almost everywhere. Varying post-glacial climate conditions, geological properties and relief formed different soils and a variety of vegetation patterns. Heavy ice cover depressed the land and consequently vast areas were covered by fresh or sea water that went through several stages due to land uplift. In the centre of gravity of the continental ice cover in Scandinavia, the land has risen by more than 800 m since the last glaciation (Sporrong, 2003) and the mean annual rate of uplift has been nearly 10 cm. In large areas of the Baltic Sea region the land uplift continues even nowadays, being higher in the Bay of Bothnia, where it is about 8-9 mm/year, and decreasing to zero in southern Sweden and Latvia and even submerging south of that imaginary line. During and after the ice cover retreated, sediments transported from Scandinavian mountains

![Figure 1.2. Expansion and contraction of cultivated area in Europe during the last millennium (Rabbinge & van Diepen, 2000).](image-url)
The Rural Landscape

Landscape boundaries, ecotones
In the Baltic Sea region there is a great variation in landscape types. These support human activities as well a rich biology through a large variety of habitats for plants and animals. The landscape varies with latitude (north to south), altitude (high or low), climate (especially wet or dry), and proximity to the sea (maritime or continental). They may be divided into vegetation zones, also called biomes (Figure 1.3).

Boundaries between different landscape types, the ecotones, often have special roles to play. For example ecotones around agricultural fields may absorb nutrients leaking from the field. Such ecotones constitute habitats for some birds and insects, and their removal in modern agriculture is negative for biodiversity. Forest edges, river shores and mountain sides are other examples of landscape type boundaries.

The science of landscape is basic for sustainable development since each type provides different ecosystems services and natural resources (chapter 2). Modern methods of landscape ecology rely on remote sensing, use of GIS, and characterise landscapes by e.g. the amount of carbon present in the soil, vegetation types, rainfall etc.

Arctic-alpine areas
At high altitude, above the tree lines, the landscape is barren due to the climatic conditions. In the north the Scandinavian mountains are called fjell; in the south we have the Carpathian range. Plants and animals in the fjell belong largely to a group of arctic species found around the polar area.

In all the mountains, both low-productive dwarf-shrub heaths and higher productive grass/herb areas can be found. More to the north or at higher elevation, lichens play a very significant role. In the north the Saami traditional economy was based on reindeer herding. Today tourism may be even more important and hundreds of thousands of visitors spend summer months touring the mountains. Large parts of the mountains are protected as national parks. A big difference between the Scandinavian mountains and the Carpathian mountains is the much larger amount of wetlands and lakes in the northern region.

Coniferous forest, boreal forest – taiga
The forest landscape, with spruce and Scotch pine, dominates northern and central Sweden and Finland and the neighbouring parts of Russia. The pine is found in both dryer and very wet conditions, while the spruce does best in more fertile soils. Fires have always played a significant role in the dynamics of the coniferous forest, especially in drier climate. The number of higher plant species in such forests is low (but there is blueberry, lingonberry, crowberry and heather); the moss and lichen flora often dominate.

Few larger mammals are specialized to live in the boreal forest. Moose belong to the coniferous forests, while brown bear, wolf, and lynx, still typical, have often been pushed out of other areas by human activity. Birds in this landscape include Ural owl, Siberian tit, and Siberian jay. Even if the Northern coniferous forests are much influenced by forestry and other types of traditional human use, parts of them can be regarded as Europe's most natural landscapes.

Box 1.1.

Mixed coniferous – broad-leaved forests
The mixed coniferous-broadleafed forests covers large parts of south central Sweden, the southern part of Finland, the Baltic republics, and parts of neighbouring Poland, Russia and Belarus. This is a transitional zone where the coniferous trees are found on infertile soils and deciduous trees on better soil. Agriculture has during a long time changed large forest areas into open grazing areas or arable land. More recently forest has largely returned in less fertile arable land and grazing areas.

The mixed forest has in addition to the coniferous trees a number of deciduous tree species. Among them we have oak, important for biodiversity; especially old oaks which can be the home for a large diversity of insects, lichens, mosses and fungi, as well as birds and even bats. Other important deciduous trees are lime, ash, elm and maple. Mixed forests are often rich in bird species and mammals, including Roe deer, and in some areas, Red deer and Wild boar.

Broad-leaved nemoral forests
In the southern parts of BSR, broad-leaved forest is the original vegetation type, except in very wet areas, and it still constitutes an important landscape type. Among tree species are beech, hornbeam and maple. The economically valuable species beech and oak sometimes dominate.

Figure 1.3. The vegetation zones in the Baltic region, with the four typical vegetation belts. Shaded areas are alpine zone, and subalpine and subarctic birch forest. (Adapted from Sjörs, in Rydin et al., 1999.)
Forests which have been used for grazing become more open, and may even form wooded meadows, although these disappear when not maintained. This landscape is often very beautiful and rich in flowers especially during spring, when Anemone and Corydalis species flower. During summer the forests are quite dark, with fewer plants, especially in the beech forests. Old forests may be very species rich and the habitat for a very large number of insects, birds, fungi and lichens.

Semi-natural grasslands have successively developed during the last 6,000 years, mostly due to long periods of grazing. There are many types of semi-natural grasslands, some totally open without trees and shrubs, and others with trees and shrubs as a prominent part. Many grasslands are extremely rich in species, and very attractive for recreation.

Only a few percent of the semi-natural grasslands of the 1850s northern Europe are left today. In Poland, the Baltic States, Norway and southern Sweden many areas survived into the 1960s, but since 1989, the regression has been tremendously fast. Recently, much work has been done to save and even restore semi-natural grasslands. The hilly landscape in south-eastern Sweden is probably the best stronghold for semi-natural grasslands in northern Europe today, and the Great Alvar on the island of Öland is Europe’s largest continuous semi-natural grassland (Figure 1.4).

Arable land
The arable landscape has developed during thousands of years. Originally this landscape included many additional elements such as ponds, small fens, trees and stone fences. As agriculture was mechanized individual arable fields have grown in size considerably and a much more simplified arable landscape has been created, especially pronounced in for example Lithuania, Scania in southern Sweden and on the Danish islands.

Fauna and flora earlier typical for the arable landscapes are today threatened by forest takeover or large-scale agriculture that leaves little room for wild species. Plant species adapted to arable fields, e.g. Centaurea cyanus, are now becoming rare due to increasingly efficient methods of threshing. Birds living in the arable landscape are among the most threatened birds in Europe today.

Wetlands
Wetland is a broad term for landscape types with the water table close to the surface. They are called mires, shores and swamp forests. Drainage campaigns has reduced wetlands dramatically in the southern parts of the region, while in the North there are still large peat wetlands. Peat is often extracted and used as a fuel.

Many wetlands have earlier been open ponds or lakes, which successively were filled up with lake sediments and later with peat as wetland plants encroached. There are also wetlands dominated by trees and shrubs. Alder dominated swamp forests and Salix dominated wetlands along lake and river shores can for examples still be found in large regions of Eastern Poland and Belarus.

Wetlands can sometimes attract a large number of birds. Sandpipers and ducks are found in most types of wetland. The crane is a species typical for larger low-productive wetlands. The impressive black storch is found in swamp forests.

Rivers and lakes
The Baltic Sea region has an abundance of lakes, only in Sweden and Finland some 160,000. The majority of these lakes are small and have low nutrient levels. Usually mires, heath and coniferous forests dominate the catchment areas.

The nutrient poor lakes in the mountains, especially in the North, have been subjected to acidification with the consequence that all higher forms of life, including fish, have disappeared. This is in particular the case if the surrounding bedrock and soils have a low buffering capacity.

The number of oligotrophic nutrient poor lakes has declined during the last 50-100 years due to changes in land use. Draining to gain arable land in the late 19th and early 20th century led to lowering of the water table of many lakes.

The Baltic Sea coasts
The coastal areas around the Baltic Sea are different compared to other coastal areas. The brackish water of the Baltic Sea influences the shore meadow vegetation, since there are considerable water level fluctuations over the year.

Some coastal areas (in the Baltic States and Poland as well as in southern Sweden and parts of Germany and Denmark) have extensive shore meadows. These are important for a number of wetland birds, such as sandpipers, and several species of geese. The South-eastern Baltic coasts are famous for their sand dunes.

Lars Rydén
settled on the old relief, forming e.g. hilly moraine relief, end moraines, ice margin deposits and drumlins. Material transported by melt water formed large sandy plains, sandurs and eskers.

During different climatic conditions of the post-glacial period, the prevailing vegetation cover and thus the overall look of the landscape changed considerably. About 10,000 BC climate grew warmer for about 1,000 years, but only territories lying in present Germany, Poland and Denmark and in southern Sweden and some higher parts of the Baltic State region and the Russian catchment area were free of ice. The sea level before the ice shield was about 50 m lower than now, allowing direct connection between present Denmark and southern Sweden. Due to melting of the ice shield and lack of connection to the Atlantic Ocean, the water level rose step by step and finally reached up to 50 m higher than the present sea level. This stage is called the Baltic Ice Lake (Figure 1.5), when intensive sedimentation of fine particles in the fresh water body formed large varved clay plains that later became marshy. The percolation of water through the soil was restricted by permafrost, and evaporation was negligible due to the very short summer when the temperature rose above zero degrees. During this period birch migrated to the north, reaching Scandinavia. The prevailing tundra-like vegetation type near the melting ice cover provided grazing for wild animals.

**The First Humans**

It is very likely that the first humans moved to the Baltic Sea region quite soon after the last Ice Age, following reindeer and elk. Step by step they settled near rivers, lakes and the sea. Later on, some headed further inland.

The hunters, fishermen and gatherers of plants, fruit and roots of this time probably did not have any large impact on ecosystems, even though the area to support one person was relatively big (Palang et al., 2003). The population density was still very low. The main factor changing the shape of landscapes was probably fire, usually of nat-
ural origin. Continuing melting of the ice cover and rising sea levels flooded large areas in present Estonia, Latvia, Lithuania, Russia and southern Sweden. The coastal line of the sea was very different to what we can see now and for example the large lakes in Sweden (Vänern, Vättern), Estonia (Peipsi) and Russia (Ladoga) formed a part of the former Baltic Ice Lake.

After the Baltic Ice Lake drained via the mountain plateau Billingen about 10,700 years ago and made a connection with the Atlantic Ocean, the water became slightly brackish (2-3‰). This period is called the Yoldia Sea (about 10,300-9,500 years ago). A further increase in the temperature during the Pre-Boreal period (about 11,500-9,300 years ago) raised the brackish water input and the sea level, accompanied by the land uplift after the ice shield melted. Finally the strait in central Sweden was closed. Birch and pine forests probably started to spread over what had once been tundra-like landscape. The transgression when water rose by nearly 10 m a century (Sporrong, 2003) gave an outlet into the Great Belt about 9200 years ago. Parts of former settlements on the coast of the sea were flooded during this period, called the Ancylus Lake (9,500-7,800 BP, before present). This was the case for example with Pulli on the bank of the River Pärnu, which is the oldest known settlement in Estonia. By at least that time humans reached southern Finland, since remnants of settlements in Lahti Ristola date back 9,250 years (Sporrong, 2003). Sand transported to the sea by rivers formed substantial dunes in many parts along the former coast. Due to the relatively warm and humid boreal climate, the overall vegetation picture was rather different compared with nowadays. Wetlands were common and the number of lakes much higher during this period. Open areas were found in the flood plains along the large rivers.

About 7,800-3,700 years ago, during the Litorina stage of the Baltic Sea, the connection to the ocean was better than ever before or since, and therefore the exchange of water between the sea and the ocean was intensive. The salinity of the Baltic Sea was fairly high, 15-18‰, providing much better conditions for many species. The sea level was only a couple of metres higher than now and thus the coast line looked rather similar to what we can see nowadays.

About 8,000-5,000 years ago, in the Atlantic Period, the climate became more humid and remained warm. The southern part of the BSR was covered by deciduous forests where the dominant tree species where oak, elm, ash and lime (Palang et al., 2003). Deciduous forests dominated even in southern Scandinavia and pine reached up to poor soils and high altitudes in Lapland. The remnants of this vegetation type can still be found, especially in the south of the region and in some sheltered areas, e.g. deep river valleys and coastal cliffs. It is likely that permanent habitation in this period reached to the islands of the Baltic Sea and developed for example on Saaremaa Island and on many Finnish islands during the Late Mesolithic Era (Kriiska, 2002). Around this time, the coastal settlements of Denmark and southern Sweden also expanded considerably (Andersen, 1993; Larsson, 1997).

Some 4,000 years ago, the temperature started to decrease, which led to immigration of spruce and pine forests to areas where oak elm and lime had previously dominated. In Western Russia spruce re-established already about 7,000 BP, and occupied vast areas in the former Baltic States and Finland during the period 7,000-5,000 BP (Björkman, 1996). From about 4,000 BP spruce forest expanded its distribution limits to the west. Spruce seedlings require sufficient insulating snow cover during the winter (Frey, 1983), which probably explains the expansion to the north in the period when the temperature started to decrease. At about 5,000-4,000 BP beech trees expanded into Poland, northern Germany and southern Scandinavia (Björkman, 1996). The invasion of this spe-
The Rural Landscape

cies has been explained by availability of habitats after the decrease of pre-existing dense woodlands due to human interference (Behre, 1988) and by a decreasing continentality in climate and milder winters. The forests became denser and darker.

During the next period, land uplift restricted the water input from the ocean and the Limnea sea level dropped to what we can see now. The water salinity decreased owing to freshwater input and continuing land uplift raised new islands from the water and reshaped the coastline.

The Man-made Landscape

The Neolithic Age

The first humans settled the Baltic Sea region very rapidly after the ice cover retreated, about 10,000 years ago. The hunters and fishermen who lived on coasts and nearby water bodies probably had quite a limited impact on the overall landscape pattern of this period (Lõugas, 1980). Humans who headed further inland burnt down forests to create more space and significantly influenced landscapes around their settlements, allowing invasion of new species such as beech. The landscape pattern was also changed by natural fires caused by lightning.

A gradual transition from hunter-gatherer to agricultural communities started in some areas in former Germany and Poland already about 7,000 years ago. It is very likely that human habitation multiplied during the long relatively warm era starting from the pre-Boreal Period. People settled near water courses and on the shores of lakes.

Towards the end of the warm period about 6,000 years ago, hunters and gatherers had invaded most of Scandinavia. The conditions for cultivation were more favourable in areas where the calcium-rich sedimentary bedrock allowed development of fertile soils, for instance in southern Sweden, former Denmark, Germany and Poland. These parts were the first to gradually change into cultural landscapes.

When climate turned cooler, opportunities to make a living with seasonal migration diminished. This created a need to intensify foraging, and it is likely that during the Late Mesolithic era, year-round villages began to arise in many places in the BSR (Kriiska, 2003). The practice of gathering firewood and timber probably generated an increase in sparse woodlands and open areas in the surroundings of year-round villages.

Loess and clayey till soils in particular are the earliest cultivated soils in this region. Step by step, a farming society based on cattle and goats and small cultivated fields started to dominate in the south of the area. A warmer period allowed cattle to be kept outside all year round and therefore additional grass production from meadows was not necessary. During the drier sub-Boreal Period starting about 5,000 years ago, when summers were warm but winters cold, cultivation was introduced in Scandinavia. Cultivation required more intensive cooperation and therefore the size of villages and population increased. Farming then continued to expand northwards, probably pushed by increasing population pressure in the south (Sporrong, 2003).

Findings of wheat, barley and oat pollen in layers of bog and lake sediments in Estonia dates back to the Middle Neolithic era, some 5,000 years ago. Evidence of farming during this period has also been found in Latvia and

Figure 1.7. Stone wall in the province of Småland, Southern Sweden. All through the landscape farmers have removed stones from the fields to make way for arable land. Photo: Lars Rydén.
Lithuania. However, farming probably remained a minor activity compared with hunting, fishing and foraging in the wild. Very little is known about cattle breeding during this period, but it probably spread during Late Bronze Age some 3,000-2,500 years ago. Extra fodder for winter time probably included twigs from aspen, birch, ash and other trees. Production and storage of hay probably started much later, when suitable cutting tools for this work were introduced in the Pre-Roman Iron Age approximately 2,500-2,000 years ago (Laul and Tõnisson, 1991).

Intensive farming allowed a much greater density of population than can be supported by hunting and gathering. This process speeded up burning of forests and the conversion of this land to agricultural land. The species composition of forests changed and the area of birch forests in the slash and burn areas increased, probably favoured by colder winters.

The Post-neolithic Period
The land reclamation activities of the post-Neolithic period involved clearing the fields of stones, which were stacked in the fields. Numerous stone heaps with a diameter of a few metres shaped the agricultural landscapes in many places in the BSR, for example in Kõmsi, Estonia (Lõugas, 1980). In older permanent fields the height of the stone heaps reached more than 1-2 m, but nevertheless it is still often difficult to see the heaps and burial mounds in the current landscape. Around 1000 AD, a landscape had developed with organised villages, which had fenced fields and grazing areas in the vicinity of buildings. By the early 11th century settlements extended to 63°N in Sweden and 62°N in Finland (Orman, 2003). While in the south the farming of permanent fields was well established, most of the northern parts of the region were still dominated by hunter-gatherers and most of the landscape remained more or less natural. Around the Gulf of Bothnia, prehistoric agrarian settlement was limited to a narrow coastal zone and lower parts of the river valleys, with very few exceptions, due to clayey lime-rich soils and better climate, e.g. around Lake Storsjön in Sweden or large lakes of southern Häme in Finland and the shores of Lake Ladoga. The northern shores of the Gulf of Finland and the east coast of the Gulf of Bothnia were practically uninhabited and had no permanent settlement before the 11th century (Orman, 2003). However, during the medieval period settlement in Finland spread from the coast to inland areas. A rapid expansion in settlement also took place around Lake Ladoga in Karelia. This expansion to marginally less fertile areas influenced farming technology. The use of iron shares for ards and ploughs spread in the region between 1000 and 1200 AD, making it easier to till heavy soils. In addition, slash-and-burn cultivation permitted the cultivation of rye even in heavy forest soils (Orman, 2003). In the early medieval period, a shift to a crop rotation system took place in large areas in Germany and Poland and spread to Denmark and southern Sweden already in the twelfth and thirteenth centuries and to Finland before the mid 14th century (Orman, 2003). This system required sufficient manure application and thus animal husbandry was a prerequisite for grain cultivation except in the slash-and-burn areas. In some areas in Denmark there was probably even some over-fertilisation and excess losses of nutrients. The crop rotation system, especially in the three-field system, included some land that was rested. Barley cultivation dominated, but later winter rye was introduced. Oats was also important but wheat was more or less a luxury product.

The Medieval Period
In areas where cattle farming was of greater importance than crop production, the proportion of meadows was high, exceeding the area of arable land in the southern Swedish highlands by about five-fold (Sporrong et al., 1995). The meadows with permanent grazing became plant species-rich, as we can see in today’s wooded meadows. From the 11th to the first half of the 14th century the population growth continued and previously unoccupied less favourable areas were taken under cultivation. This process led to an increased number of rural holdings (Table 1.1). In early medieval times, settlement probably spread

Table 1.1. Late medieval rural settlement in Scandinavia and Estonia
(Source: Orman, 2003, modified)

<table>
<thead>
<tr>
<th>Region</th>
<th>Number of rural holdings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present Denmark</td>
<td>110,000</td>
</tr>
<tr>
<td>South Sweden</td>
<td>52,000</td>
</tr>
<tr>
<td>The Swedish provinces</td>
<td>75,000</td>
</tr>
<tr>
<td>Estonia</td>
<td>6,000</td>
</tr>
<tr>
<td>Finland</td>
<td>13,000</td>
</tr>
</tbody>
</table>
to the remaining forest regions in Denmark. Population growth caused emigration from more densely populated areas in Denmark, southern Sweden and Germany to the more sparsely populated eastern parts of the BSR and the southern coast of the Baltic.

**From 1600 to Today**
The farming system in the Baltic Sea region changed rather slowly and forest fire, partly of natural origin, was still the main factor shaping the landscape. Repeated burning, a common cultivation procedure in different parts of the BSR until the 17th century, continued in some areas until the second half of the 19th century. In the 17-18th century, use of forests for manufacturing and production of heating wood increased considerably, rapidly enlarging the clearcut area. Around many big factories, mines and cities, the forests disappeared almost entirely, as happened for example around Tallinn in Estonia. The area of forests decreased by more than 50% in southern Estonia and northern Latvia and 30% in northern Estonia during the 18th century and formed only 19.8% and 24.4%, respectively, in these parts of the BSR by 1887 (Cvetkov, 1957). Increased wind erosion damaged agricultural land. Domestic animals needed additional feed during wintertime in the colder climate and collection of hay for fodder, brought from wetlands and meadows, became common practice. When the animals were kept inside for some part of the year, it was possible to collect manure for fertilisation and agriculture became more intensive. The land area under agriculture increased, but where manure was not available the soils became exhausted. Gradual specialisation and exchange of goods paved the way for a denser population outside the best agricultural regions.

The number of inhabitants was still rather low in Scandinavia until the 19th century, when the hunting-gathering lifestyle was replaced by farming almost everywhere.

From about the middle of the 18th century the area of fields increased quite rapidly. Population pressure was high. Meadows were turned into fields and much wetland was taken into use after drainage of the areas. A crop rotation system was widely implemented, made possible with the use of manure as a fertiliser. The size of farmsteads was probably restricted by labour costs for manure transportation. In the north of the region the climate restricted agriculture, so here hunting and fishing remained the most important way of living until the 20th century.

**The Main Categories of Landscape Transformation**
The main factors influencing the land use structure can be classified as natural, political and socio-economic (Sepp, Chapter 2, this publication). The impact of natural factors usually changes quite slowly.

The area under cultivation reached its peak at the beginning of the 20th century (Sporrong, 2003) due to...
population pressure and reached the limits for production without extra energy input (such as use of soil management machinery and chemical fertilisers). Consequently the area of forest was minimal at that time.

Today farmland can be found mainly in regions where the soils and climate conditions are more favourable, e.g. in Denmark, Germany, Poland, the Baltic States and in southern Sweden, the Central Swedish depression and along the shores of the Gulf of Finland and the Bothnian Sea (Figure 1.11). The forests have mainly retreated to the less fertile soils. The proportion of cultivated land varies greatly from few percent up to 70% in Denmark and in some areas of Germany and Poland.

Among the main factors determining the development of current land cover are land reforms, urbanisation and changes in social structure. Socio-economic factors include land amelioration (drainage, irrigation), forestry (deforestation) and concentration of agriculture.

**Drainage**

The increasing population required more and more land for food production in the BSR. Due to excess precipitation, drainage is needed in large areas of the Baltic Sea catchment and drainage of land was able to increase crop and forage production areas in landscapes with peat soils and wetlands. Thus drainage has been one of the main recent factors reshaping the landscape, e.g. in Denmark and in the province of Schleswig-Holstein in Germany most mires had disappeared by the 20th century due to drainage operations.

The first attempts to regulate water runoff with the aim of getting rid of excess water were made in the Baltic Sea region back in the Middle Ages. Water energy was first used for water mills. A river closed by a dam supplied water seasonally more evenly and helped to prevent floods.

In Denmark and Germany, intensive land reclamation campaigns started in the second half of the 19th century. Similarly in Sweden land reclamation through water drainage projects was most intensive during this period. Consequently, agricultural land area more than doubled in the 19th century and intensive drainage lasted until the middle of the 20th century, when about one-sixth of the total agricultural land had once been a lake or a wetland (Anderberg, 1991).

In Russia and the Baltic States, drainage was rather local until the 19th century (Karavayeva et al., 1991). Tile drainage started in the middle of the 19th century and during the first half of the century only some 7,400 ha were drained in the west of Russia (Karavayeva et al., 1991). In Estonia about 108,000 ha had been drained by 1917, mostly in forest areas, and the area increased to more than 350,000 ha by 1940 (Juske et al., 1991). Drainage reached its peak in 1960-1980, when, for example in Estonia, more than 56,000 ha were drained from 1966 to 1975 (Figure 1.10). Now about 727,000 ha, or more than half the agricultural area, are drained in Estonia, including 7,600 ha of polder systems. In addition, about 601,000 ha of forest land are drained and the total drained area forms about 30% of Estonian territory.

In Finland the systematic drainage of agricultural land started on bigger farms in the 1850s and land reclamation reached its peak during and after World War II, when more agricultural land was needed to feed the people and to settle Karelian refugees.

The history of drainage in Belarus dates back to the second half of the 18th century. At the end of the 19th century, extensive drainage works were carried out in the Polesie region. However, Belarus still had the largest marshlands in Europe before a large-scale land reclamation campaign started in the second half of the 20th century following the ‘Land Drainage and Sovkhoz Building Act’ of 1966.
about 3 million ha of large former swamp areas have been drained and converted to agricultural land.

In Latvia quite extensive land drainage started in the 18th century in the east of the country. By 1995, almost 1.6 million ha had been drained. The first subsurface drainage systems in Lithuania were installed back in 1855, but large-scale drainage started in the second half of the 20th century and the total drained area is about 3 million ha. Nevertheless, the share of drained land in the Baltic States has remained relatively low compared with that in western European countries.

Drainage changed and removed habitats for many plant communities and thus shaped the pattern of landscape mosaic. The mires and large floodplains of unregulated rivers disappeared and were replaced by arable land and grassland. The dominant vegetation type of drained forests also changed, generating new spatial patterns.

Many drainage systems on the eastern coast of the Baltic Sea have not been maintained properly during the past 15 years. Many ditches and small streams are overgrown with bushes and other high vegetation, which is slowing down the water flow velocity, prolonging retention periods and thus enhancing the self-purification capacity of streams in agricultural areas.

Due to the climate, irrigation is only used for special crops such as strawberries, fruit trees, and other valuable crops in the Baltic Sea region. The area equipped for irrigation as a percentage of the total arable land area is relatively high only in Denmark and in some parts of Germany, Finland and Sweden.

**Deforestation**

Deforestation is the main factor contributing to landscape patterns. This process can be driven both by natural and human-induced processes. Natural causes of deforestation are fires caused by lightning, floods and storms. Natural fires leave mosaics of burned and un-burned vegetation, fairly common in many fire-sensitive areas in the Baltic Sea region. These disturbances are usually quite local and recovery through succession takes a maximum of one hundred years. Thus succession plays the most important role in creating a heterogeneous vegetation mosaic of forest.

Human activities contributing to deforestation are mainly forest harvesting, but partly also human-induced
This page discusses the impact of forest fires and human activities on landscape change in the Baltic Sea region. It highlights the use of fire for cultivation, the role of manure as a fertilizer, and the expansion of agriculture. The text also mentions changes in woodland area between 1960 and 1993 for various countries. The table shows a decrease in wooded area in some countries and an increase in others, with the share of forest and other wooded land in land cover varying from about 15% in Germany and Denmark to 70% in Sweden. The text concludes with an overview of expanding agriculture, noting the transformation of forested areas into agricultural land.
The Rural Landscape

the catchment (HELCOM, 2004) (Figure 1.11). Central and northern parts of Sweden and Finland are still typical lake and mire landscapes with very thin soils unsuitable for cultivation.

The area of agricultural land reached its maximum in the BSR by around 1900. By 1920 the total field area in Sweden had increased by more than six-fold compared with 1750, to occupy more than 9% of the total land area. By this time also about 65% of the Estonian territory was in agricultural use (Palang et al., 2003). After this maximum, the agricultural area decreased in both countries and has now nearly halved in Sweden and forms only about 18% of the land area in Estonia. In Denmark the area of forests has been reduced to 3% of the total land cover by about 1800 (Palang et al., 2003). Today the forest area in Denmark has increased to 16% of the total land area. In recent years, the number of agricultural holdings and number of active farmers have decreased in most of the countries around the Baltic Sea, while the average size of agricultural holdings has increased.

The impact of enlarging open agricultural land areas has been controversial. It has had negative consequences on the total area of wetlands and natural forests. Disruption of ecological processes, habitat loss and fragmentation are typical processes taking place in agricultural landscapes. Consequently, contiguous land cover (e.g. forest) can break down into isolated patches when the area cleared exceeds a critical level. At the same time fragmentation of landscapes decreases the inner area of patches and forms more borders in the landscape, increasing the overall ecotone area, the boundary or transitional zone between two ecological communities. This process has created more niches for the species of open habitats and light-rich forests. Agriculture also enhances the spread of weeds and other invasive species. Agriculture contributes to changes in soil nutrient content in different ways: soils can both become poorer due to agricultural crop uptake of nutrients or richer due to overfertilisation.
Today’s Landscapes

Layers of Time
In most landscapes we can distinguish layers from different historical periods. Some very old landscape elements such as burial mounds, remnants of fortifications and stone walls around fields date back to the ancient prehistoric period, and are easily visible even today. Other human landscape influences are not that easy to detect. In many places in the BSR, buildings from medieval times can be found. The mosaic of estate landscapes with numerous parks and building complexes is dominant in many places in Germany, as well as in the Baltic States and in other areas. Windmills are specific visible landmarks still reminding us about earlier agricultural practices, especially in coastal areas. These traditional old landscapes still shine through even though they are largely changed by industrialisation, increase of field size due to intensive amelioration in more favourable agricultural areas, and the spread of urban areas (Figure 1.13). Thus, past functioning has produced today’s landscape’s structure, just like today’s structure produces today’s functioning and today’s functioning will produce future structure (Forman and Godron, 1986). We could actually call these types of landmarks the landscape memory.

Today, industrial landscapes dominate in some regions in all countries surrounding the Baltic Sea. New layers of elements add to the landscape ‘cake’ contributed by modern wind turbines, high grain storage silos, manure storage, waste water treatment facilities, etc. in the rural

Figure 1.12. Aerial patchwork landscape in Käseberga, Southern Sweden. Photo: Christopher Line.
One of the more drastic examples of recent changes in land use in the BSR is the Chernobyl accident in the Soviet Union (Ukraine) in 1986. Since then, long-term radiation has affected e.g. 18% of the most productive farmland in Belarus and 20% of its forest area. This area is today forested but excluded from food or feed production and it has a very low human population.

Thus the landscape is a complex entity which operates over numerous temporal and spatial scales as described by Antrop (2000).

**The Sustainable Landscape – What is it?**

The Baltic Sea drainage basin is roughly four times the surface area of the sea itself. About 48% of the region is now forested, with Sweden and Finland containing the majority of the forest, especially around the Gulfs of Bothnia and Finland. About 20% of the land is agricultural land, mainly in Poland and around the edge of the Baltic Proper, in Germany, Denmark and Sweden. Nearly 17% of the basin is unused open land, with another 8% of wetlands. Most of the latter are in the catchments of the Gulfs of Bothnia and Finland. The rest of the land is heavily populated.

We use landscapes for different purposes:

- To produce resources (e.g. forestry, agriculture, rearing animals, mining minerals)
- To give space for human infrastructure (buildings, transport, industry)
- For recreation
- For ecosystem services (i.e. flooding control, water supply)
- To support aesthetic, cultural and religious values
- To support components and structure of ecosystems

Very often these goals are in conflict with each other. Therefore optimisation of land use and a more sustainable approach with regard to landscapes are needed.

Characteristic features of sustainable landscapes are self-sufficiency and variety of ecosystems, high environmental quality and maintenance of natural resources. In urban and rural areas sustainable landscapes provide enhanced landscape beauty; less environmental degradation; more effective use of water, timber, fertilisers and other resources; more valuable wildlife habitat; and cost savings from reduced maintenance, labour and resource use.

The optimisation and management of landscapes should follow the basic principles of sustainable landscape maintenance. We should take into account that the impact of human activities in the landscapes can be visible after a time lag of several years. Fragmentation of landscape mosaic by human settlements and land use will not necessarily lead to a decrease in species diversity. In contrast, maintaining large monoculture agricultural fields can cause undesirable results. We should also remember that only those species that are suitable for specific climatic, hydrological, soil and geo-morphological conditions can be introduced. Otherwise, lots of resources would have to be spent to maintain communities by e.g. drainage, irrigation, fertilisation, chemical treatment. This is not in agreement with the principle of sustainable landscapes.

Sustainable landscapes will support abiotic landscape resources, e.g. local climate and water availability, as well as biotic resources such as biodiversity and ecological functioning. Sustainable land use also implies reduced inputs of resources and pollution, and maximised re-use of resources. Finally, sustainable landscapes look more attractive. Thus sustainable landscapes are valuable due to a number of criteria, including producing resources, providing a space for human infrastructure, recreation and ecosystem services, and supporting aesthetic, cultural and religious values as well as components and structures of ecosystems.
Introduction


The New Sustainable Frontier – Principles of Sustainable Development (published by the US General Services Administration, Office of Governmentwide Policy)


Chapter 1


References


Chapter 2


