CHAPTER 2

A COUNTRY PROFILE

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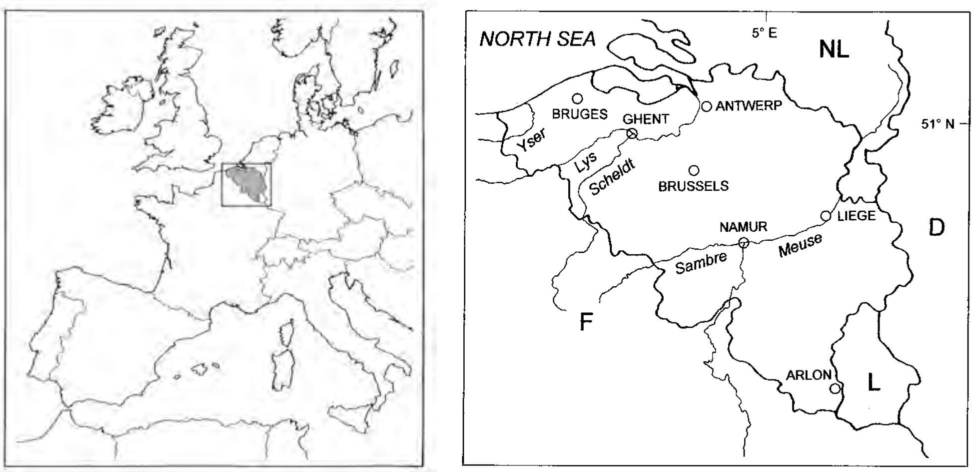
1. BELGIUM IN A NUTSHELL

"Belgium is a disconcerting country where paradoxes thrive". This is how Jacques DENIS introduces Belgium in his book 'The Geography of Belgium' (1992). Indeed, Belgium is a small country with a surface of only 30,528 km^2. Yet for such a small area, it shows a very high diversity of landscapes with the high plateaus of the Ardenne in the south, the large river valleys of the Meuse and Scheldt, the fertile loess areas in the centre, the coastal low-lying polders, etc. This specificity is due to a unique combination of natural features (climate, geology, etc.) and human activities (mainly land use for agriculture, industry



Total surface area: 33,990 km^2 (incl. Belgian waters)
Terrestrial surface area: 30,528 km^2
Population: 10,309,725 (2002)
Population density: 338 inhabitants/km^2 (2002)
Highest point: Signal de Botrange (694 m)
Land cover: 58% agriculture, 20% forests, 19% urban, 3% other (2002)
Length of road network: 149,028 km (2002)
Constitution: monarchy
Government type: federal parliamentary democracy
Independence: 4 October 1830
Provinces: 10
Official languages: Dutch, French, German
Currency: euro (EUR)
Gross national product: 252.5 billion EUR (2002, estimate)
Annual growth rate: 0.7% (2002, estimate)

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Location and main features of Belgium (drawing by H. VAN PAESSCHEN). Statistical data from the National Institute of Statistics (NIS-INS, http://www.statbel.fgov.be).

and housing). Historically, the Kingdom of Belgium is a young nation: its present borders have been delimited in the 20th century. But it is also a country of long-standing civilisation. Several cultural backgrounds coexist side by side. The political and administrative organisation of the country is complex, with different levels of competences that interlink closely. Despite these paradoxes, 'Belgium, heart of Europe' is not just a catch phrase. Not only does Belgium host the geographical centre of the 15 countries of the European Union (in the small village of Oignies-en-Thiérache), but it is also at the confluence of two major bio-geographical regions of Europe (Atlantic and Continental) and is one of Europe's main economic and urban nerve centres.

This chapter presents the major bio-geographical features of the country and outlines its administrative organisation, giving an overview of the main factors influencing biodiversity and the structures competent for its conservation.

2. Topography and main regional units

One of the most famous Belgian songs, by Jacques Brel, refers to Belgium as 'the flat country' (Le plat pays / Mijn vlakke land). Belgium certainly deserves this nickname, as the altitude reaches the impressive height of ... 694 m at its highest peak. Near the coast, the 'polders' even lie below sea level.

Flat, however, does not mean monotonous. At the macroscale, Belgium can be divided into three major topographic units: the Sambre and Meuse axis in the centre of the country, the regions south of the axis and the areas north of it. The central region displays a rolling landscape; the southern part of the country is hilly with large plateaus intersected by deep valleys, whereas the northern region is mostly characterised by a flat topography.

2.1. The Sambre and Meuse axis

The Sambre and Meuse axis spreads in an oblique way first along the Sambre river from the French border, then along the Meuse river to the Dutch border. It includes the alluvial plains of the two rivers as well as their valley slopes. The troughs are situated at about 100 m above sea level, with many alluvial terraces some tens of metres higher. The morphology of this region is strongly influenced by the underlying geology. The northern scarp of the axis is made of calcareous limestone deposits, which feature the famous caves of Neanderthal men in Spy and Engis.

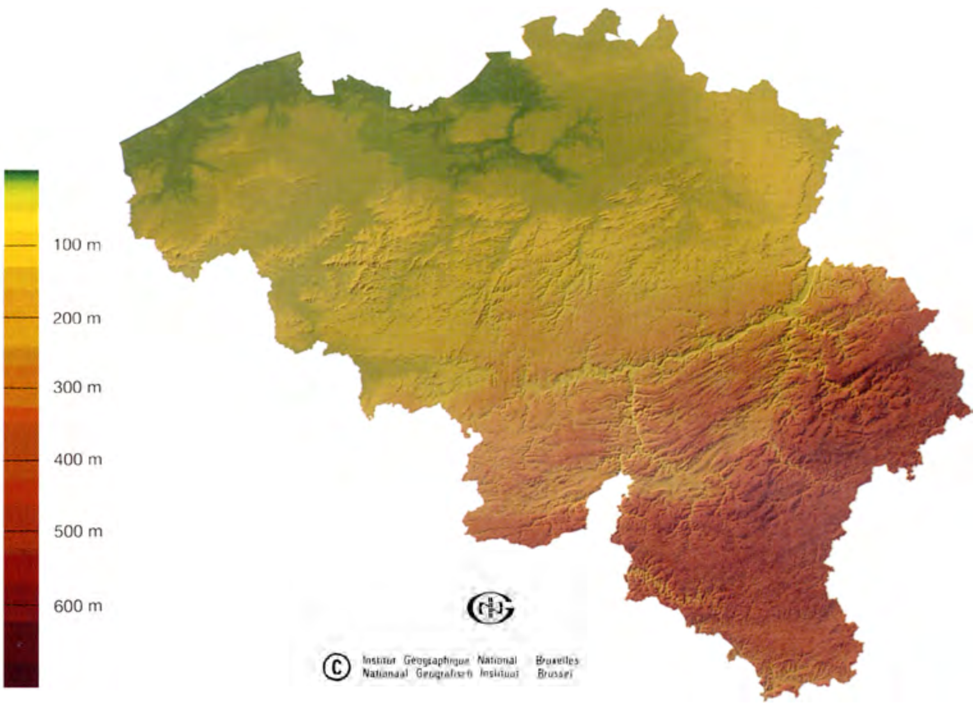
2.2. South of the Sambre and Meuse axis

The area south of the Sambre and Meuse axis is located mostly above 200 m. This part of Belgium is formed by an erosional relief that developed in hard and folded Paleozoic sedimentary rocks, yielding a landscape made of steep-sided valleys intertwined with high plateaus of relatively constant altitudes. The area can be subdivided into three broad units, the Middle Plateaus, the Ardenne and the Belgian Lorraine, which can themselves be refined into smaller entities.

The **Middle Plateaus** are situated between the Sambre and Meuse valleys and the Famenne depression. They do not get much higher than 300 m, except for the Herve Plateau, in the east, which rises to a height of 350 m. This plateau is formed by a long ridge in a southwest-northeast direction and numerous small down-warped valleys, the heads of which are affected by landslides. Its typical landscape is that of the bocage, a network of pastures and orchards interspersed with hedgerows. Two main rivers cross the Middle Plateaus: the Meuse and the Ourthe.

The Condroz, the second largest geomorphological region in southern Belgium, makes up the central part of the Middle Plateaus. The topography is formed by a succession of parallel crests, locally reaching 325 to 350 m, and depressions at 225-250 m. The crests correspond to sandstone outcrops, while the depressions are carved out in limestone and schists. Poor, dry soils and a sunny, but windy, climate have led to the maintenance of large residual forested areas on the plateaus. The Marlagne-Ardenne Condroz is a narrow region of a few km wide that stretches out as a ridge from west to east across Wallonia, between the Sambre and Meuse axis and the Condroz. It can be described as a miniature Ardenne at an elevation of around 225 m.

The Fagne-Famenne is a long depression spreading from west to east between the Condroz and the Ardenne. It splits into two parallel parts, according to the proportion of schist and limestone in the rock. In the north (150-180 m), most of the rock is schist with a few isolated limestone hillocks. It is the schistose Fagne-Famenne, often simply referred to as the Fagne-Famenne. The cold, heavy clay soils, often waterlogged, have led to the predominance of pastures and forests in this area. The southern part is quite the opposite: it is mostly made of limestone, with outcrops of schist. This is the limestone Fagne-Famenne, with an altitude at



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Topography of Belgium.

around 250 m. It is in this area that the most spectacular karstic systems of Belgium are found. Acid waters descending from the Ardenne created the most important caves of the country, like those of Han-sur-Lesse, Rochefort and Remouchamps. Botanists generally refer to the southern part of the Fagne-Famenne, with its south-facing limestone slopes, as the Calestienne. Due to particular living conditions -a shallow layer of soil rich in calcium, which warms and dries up rapidly- the hillsides of the Calestienne shelter a very specific Mediterranean-tinted vegetation of exceptional richness. The insect fauna is also particularly rich, hosting among others the discreet mountain cicada (*Cicadetta montana*).

The **Ardenne** is the most important geomorphological region south of the Sambre and Meuse axis and the most elevated area of the country. Covering more than 5,000 km^2, it belongs to the western part of the schistose massif of the Rhine basin, which spreads further into France and the Grand Duchy of Luxembourg. It rises progressively from west to east, through a series of small plateaus separated by deep valleys. Altitudes range from 300 m near Chimay, close to the French border, to 694 m on the plateau of the Hautes Fagnes, where the Signal de Botrange constitutes the highest point in Belgium. The landscape alternates between vast forested areas (mainly semi-natural beech forests and spruce plantations) and agricultural land where pastures predominate. Heathlands and peat bogs are found on the poor soils of the high plateaus.

Several distinctive sub-regions can be characterised. FOURNEAU (1990) identifies five major ones. The first is formed by the large depressed zones of the area of Vielsalm and the Amblève river. The second corresponds to karstic phenomena in the region of Stavelot-Malmedy. This is a rare feature in the Ardenne, which normally does not host any calcareous substrates. A third sub-region originates from spectacular steeps created by differential erosion of the underlying substrate (Colenhan, Chefosse, Borzeux and Erlinchamps). A fourth area is the Pays de Theux, a landscape of small, elongated condrozian-type hills alternating with small depressions in the middle of a more traditional Ardenne landscape. A last very particular sub-region is formed by the peat bogs and small annular hillocks that scatter the plateau of the Hautes Fagnes. These hillocks or 'palses' result from the peri-glacial climate and correspond to levees of soft material of 2 to 3 m high, usually ring-shaped, gentle-sided and reaching a diameter from 15 to 200 m. Their centre has subsided following climate warming, leaving place to central zones of more humid bogs or ponds. The hillocks host dryer heath vegetation while the more humid centres have a flora typical of *Sphagnum* acid bogs. The Hautes Fagnes are now designated as a Natural Park and host Belgium's largest nature reserve (3,800 ha).

The **Belgian Lorraine**, south of the Ardenne, forms the very southern tip of Wallonia. It corresponds to a small fragment of the Paris Basin, a vast sedimentary basin spreading over half of northern France and the southern part of the Grand Duchy of Luxembourg. The region is considered as a plateau but it is actually more complex, as it is shaped into a succession of three depressions (the valleys of the Semois, Ton and Vire rivers) alternating with the higher elevations of three cuestas. Cuestas are elongated hills with asymmetric slopes. In the Belgian Lorraine, the steep slopes (or 'fronts') are oriented northwards, while the gentle slopes (or 'backs') face south. The depressions generally correspond to friable rocks such as clay, marl and sand, and the cuestas to more resistant and compact rocks such as sand- and limestone. The altitude ranges from 200 m in the valley of the Chiers to 465 m near the source of the Semois. Thanks to its particular geology and topography, the Belgian Lorraine is characterised by exceptionally rich biological resources. It is often referred to as the 'Belgian Provence' as many Mediterranean species can be found on the warm south-facing slopes.

2.3. North of the Sambre and Meuse axis

The region north of the Sambre and Meuse axis belongs almost entirely to the Scheldt basin. It is situated below 200 m, except for a few sites bordering the Sambre and Meuse axis, and gradually decreases to sea level in a north, north-western direction. Most rivers do not flow directly to the coast but rather follow a southwest-northeast direction, parallel to the Belgian shoreline. The hydrographic basin is locally vigorously chiselled by rivers and their tributaries, such as along the upper courses of the Scheldt, the Dender, the Senne and the Dyle. These valleys are most often asymmetric: the principal river valleys display steep east-facing slopes while the steepest gradients for their tributaries are observed on north-facing slopes.

The northern part of Belgium consists of nine large morphological units: the Haine Valley, the Haut Pays, the large interfluvial hilly area, the Flemish Valley, the northern cuestas, the Kempen Plateau, the Limburg section of the Meuse Valley (called in this case by its Flemish name, the Maas), the coastal plain with the polders and the coast.

The large **Haine Valley** is situated in the western part of the country, north of the Sambre and Meuse axis. It is a synclinal valley mostly lying below 30 m that follows an east-west direction and includes large basins with peat and alluvial deposits. It hosts valuable humid areas.

The southern flank of the Haine Valley is dominated by the **Haut Pays**, which shows the characteristics of a plateau, with some steep-sided valleys evoking those located south of the Sambre and Meuse axis. The area east of the upper course of the Haine river presents a much higher elevation than the surrounding area and forms the Anderlues Plateau culminating at 212 m. To the west of the upper Haine, the relief is only slightly differentiated and rarely exceeds 120 m.

Between the coastal plain and the Meuse lies a **large interfluvial hilly area** cut by the valleys of several important rivers flowing in a north-eastern direction. It can be divided in a series of secondary interfluves. The most western interfluve is the one between the coastal plain and the river Lys. Although it is generally low-lying, it contains three cuestas, one of these (Tielt) reaching 50 m. Close to the French border, near Ieper, this interfluve also hosts the most western part of a hilly area referred to as the Flemish Hills. The highest point is Mount Kemmel, which, at 156 m, towers the plains of the Lys and the Yser. The smallest and least diversified interfluve is the one between the Lys and the upper Scheldt. It is topped by a loess layer covering an important fluvial terrace. The two secondary interfluves between the Scheldt and the Dender and between the Dender and the Senne are slightly more elevated and show more pronounced fluvial features. The Flemish Ardennes is a hilly country located between the Scheldt and the Dender, its highest point being the Pottelberg (157 m). It is a varied landscape, with wooded hills and numerous old Scheldt meanders, ponds and streams. Further to the south-east, the major interfluve progressively rises to reach large continuous and flat areas that have long been considered as low plateaus: from west to east, the Plateaus of Hainaut, Brabant and Hesbaye. All are located between 100 and 200 m of altitude. The Hainaut Plateau, at around 100 m, is made of a succession of gentle-sided valleys and soft interfluves in a south-west to north-east orientation. The Brabant Plateau differs from the previous by a higher elevation (200 m) and by an abrupt change in height of several tens of metres at its western border. The Hills' Country (Pays des Collines), west of the Hainaut Plateau, forms the prolongation of the hilly areas of Flanders. It is a small region with symmetric hillocks reaching about 150 m. The Hesbaye Plateau is characterised by a gently undulating surface crossed by two major rivers, but does not have its own hydrographic network. The landscape of the large interfluvial hilly area is mostly dominated by agricultural land on the plateaus, with some of the hilly areas being more wooded and pastoral.

To the north of the interfluve complex lies the large depression formed by the **Flemish Valley** and its eastern and southern branches. The valley forms a vast sandy plain to the north of Ghent, where it reaches a width of 60 km and an altitude of 4 to 10 m. The Flemish Valley has ramifications in all the major river valleys. The southern branch spreads for 20 km south of Ghent, while the eastern branch extends till Diest. The sandy cover of the valley is crossed by alluvial plains and is dotted with numerous eroded sandy hills. The rivers draining the Flemish Valley and its tributaries form large meanders within the alluvial plains. Important river dune complexes, up to 10 m high, can be found along the alluvial plains. In some locations in the alluvial plains, elevated sandy hillocks (called 'donken') are present. The lower courses of the Scheldt, the Rupel, the Senne as well as the entire Durme river are under tidal influence, giving this area a peri-marine character. Important dikes prevent the semi-diurnal flooding of the alluvial plain, but risks of inundation cannot entirely be excluded when exceptional tides concur with stormy weather at the coast. This sandy landscape has been transformed into agricultural land (i.e. horticulture and market-gardening).

The **northern cuestas** extend between the north of the oriental branch of the Flemish Valley and the Dutch border. This area includes the clayey cuesta of Boom, the large depression of the Schijns and the Kleine Nete rivers and the clayey Kempen cuesta. The Boom cuesta has a 'front' height ranging from 25 to 50 m and consists of three sub-cuestas, while the Kempen cuesta rises between 20 and 30 m and forms an interfluve between the basins of the Scheldt and the lower Meuse. The 'back' of the Kempen cuesta drops very gently to the north, accommodating large flat stretches with important dune areas (i.e. Kalmthout nature reserve). The 'Heath of Kalmthout' (Kalmthoutse Heide), the second biggest nature reserve in Belgium (about 800 ha of public land), is a typical representative of lowland heaths. Its semi-natural vegetation, largely influenced by man, is dominated by heather and a variety of grasses, with a scattered presence of trees (mostly pine and birch).

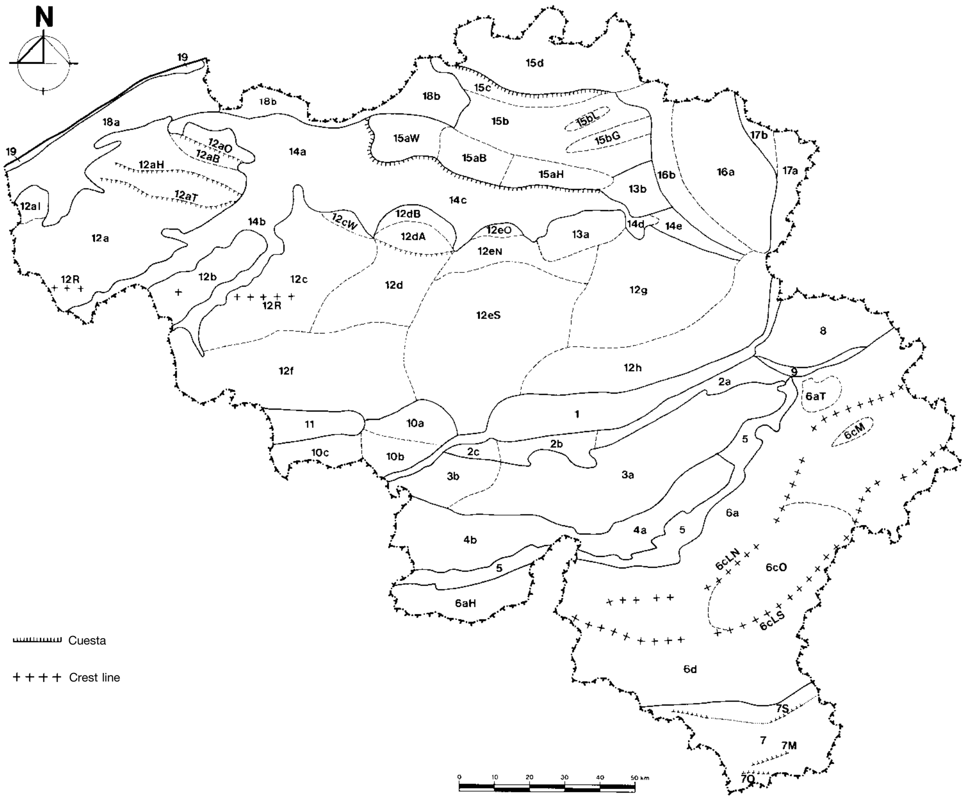
The **Kempen Plateau** is situated more to the east. It is a large, levelled plain with a gentle slope to the north. Its altitude decreases from about 100 m in the southernmost part to 30 m near the Dutch border. Its southern border is characterised by a well-marked and steep slope near the Maas (Meuse) Valley, reaching a difference in level of 40 m in some places. The entire plateau is topped by a thick layer of rough gravel, with boulders occasionally reaching several tonnes, covering a sandier substrate. The Kempen Plateau hosts important continental dune fields. Heaths, dunes and conifer woods are the main landscape elements on the poorer sandy soils, while grasslands and pastures occupy the more fertile soils.

The **Limburgse Maas** (or Maasland) is the part of the Meuse Valley situated downstream of Maastricht, along the Belgian-Dutch border. The valley bottom consists of two elements: the low terrace of the Meuse river and an alluvial plain. The low terrace is situated between 30 and 45 m, on sandy soils gradually becoming siltier to the south. The alluvial plain lies some metres below the terrace and hosts the large meanders of the Meuse river, as well as numerous oxbow lakes. The region is an important passage for migrating birds.

The **coastal plain and the polders of the Scheldt** are the lowest areas in Belgium and are part of the large maritime plain stretching from Cap Blanc-Nez in France to Denmark. Altitudes generally range from 3 to 5 m above sea level, but can also be below sea level in the polders. These areas would be flooded at high tide if they were not protected by coastal dunes, or when these are missing, by an elaborated system of dikes and locks. In Belgium, the coastal plain is usually not broader than 15 km except in the Yser basin. The Scheldt polders border the left side of the maritime Scheldt, forming a vast region north of Antwerp and extending to the south well beyond Temse. The maritime Scheldt, with a mouth width of 5 km, has a complex tidal structure with a far-reaching effect inland: the tidal range exceeds 2 m in Ghent, more than 170 km upstream. These inland areas, covered by very fertile soils, are often cultivated or used as grasslands. They also have a very important value for nature, serving as resting or feeding places for water or wintering birds.

The coastal plain and the Scheldt polders are covered by tidal sediments. In fact, the entire area was gained from the sea through the construction of dikes and artificial drainage. Before the construction of dikes, sea water penetrated via tidal channels cutting through tidal flats. Typical mud flats and marshes can be found here. In direct contact with the Scheldt estuary, the 'slikke' correspond to lower, muddy areas that are flooded twice a day by the tide. Communities are typically dominated by polychaete worms and bivalve molluscs. The high biomass of invertebrates provides an important food source for waders and wildfowl. Scattered vegetation is found mainly at the limit with the 'schorre' (e.g. *Salicornia europaea*). The 'schorre', situated just above the 'slikke', are flooded during exceptional tides only. These salty meadows generally show parallel vegetation belts that correspond to a gradient of salinity tolerance of the species. Because of their extremely high biological value, especially for plants and birds, many of 'slikke' and 'schorre' areas have been granted protection status (see chapter 6, partim Flanders). In this regard, the Zwin nature reserve is one of Belgium's most important protected areas. Located on the Belgian-Dutch border, it has a surface of 125 ha on the Belgian territory and about 25 ha on the Dutch territory.

The Belgian **coast** is 66 km long and almost straight. It includes a continuous coastal dune system that dominates the maritime plain on one side and the foreshore on the other. This dune system, which hardly exceeds an altitude of 20 m, has a variable width: it reaches several km close to the French and Dutch borders, but rarely exceeds 200 m along most of the Belgian coastline. In some places, the mobility of the dunes is important and results in the formation of blow-out depressions often reaching the water table. The natural formation of dune ridges results in the creation of humid dune slacks (or 'pannen') that divide successive ridges. Because of their low-lying topographic position, slacks are sheltered from the wind, often seasonally flooded, and usually have a water table within 1 m of the surface. Dunes surrounding a slack have an important effect on its development because organic and inorganic materials move down into the slack. Wind erosion also transports organic matter into the slack. The range of communities found is considerable and depends on the structure of the dune system, the successional stage of the dune slack, the chemical composition of the sand and the prevailing climatic conditions. These small biodiversity oases are highly threatened by the lowering of the water table.



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Main geomorphological units in Belgium (from Denis 1992, courtesy of Dexia).
1. Sambre-Meuse axis, 2a. Ardenne Condroz, 2b. Marlagne, 2c. Northern Thudinie, 3a. Condroz Plateau, 3b. Southern Thudinie, 4a. Famenne, 4b. Fagne, 5. Calcareous strip, 6. Ardenne, 6a. Northern Ardenne, 6aH. Thierarche, 6aT. Theux depression, 6c. Central Ardenne, 6cLN. Northern crest line, 6cLS. Southern crest line, 6cO. Depression of the two Ourthes, 6cM. Malmedy depression, 6d. Southern Ardenne, 7. Belgian Lorraine, 7S. Florenville cuesta, 7M. Virton cuesta, 7O. Torgny cuesta, 8. Herve Plateau, 9. Vesdre Valley, 10a. Lower area of Charleroi, 10b. Anderlues Plateau, 10c. Haut Pays, 11. Haine Valley, 12. Large hilly interfluvial area, 12a. Interfluve of coastal plain and Lys Valley, 12al. Izenberghe Plateau, 12aT. Tielt cuesta, 12aH. Hertsberge cuesta, 12aB. Beernem depression, 12aO. Oedelem cuesta, 12b. Lys-Scheldt interfluve, 12c. Scheldt-Dender interfluve, 12cW. Wetteren glacis, 12d. Dender-Zenne interfluve, 12dA. Asse cuesta, 12dB. Buggenhout glacis, 12eN. Plateau of northern Brabant, 12eS. Plateau of southern Brabant, 12eO. Okkerzeel glacis, 12f. Hainaut Plateau, 12g. Low hills of the Wet Hesbaye, 12h. Plateau of the Dry Hesbaye, 12R. Crest line of the Flemish Hills, 13a. Hageland hills, 13b. Lummen hills, 14a. Flemish Valley, 14b. Southern branch of the Flemish Valley, 14c. Eastern branch of the Flemish Valley, 14d. Halen-Schulen depression, 14e. Demer Valley, 15. Northern cuestas, 15a. Boom cuesta, 15aW. Country of Waes, 15aB. Boom area, 15aH. Heist-op-den-Berg area, 15b. Schyns-Nete depression, 15bL. Lichtaart interfluve, 15bG. Geel interfluve, 15c. Brasschaat glacis, 15d. Kempen cuesta, 16a. Kempen Plateau, 16b. Beringen-Diepenbeek glacis, 17a. Plain of the Limburgse Maas, 17b. Ledge of Gerdingen-Bocholt, 18a. Coastal plain, 18b. Scheldt polders, 19. Dune line.

The present-day intertidal zone is widest (more than 500 m) at the western limit of the Belgian coast, where the average tidal range is also the most important (4.5 m). On the eastern side, where the average tidal range is only 3.6 m, its width does not exceed 200 m. The width of the intertidal zone is not only influenced by its tidal range but also by its slope, which varies all along the coast. At some places, the intertidal zone is severely eroded. This is not only due to harbour construction works but also to natural and local cyclic phenomena. In order to fight this erosion, more than 70% of the coast is now protected by longitudinal dikes, groynes, artificial raisings and other man-made constructions. These artificial structures create new surfaces for colonisation by species typical of hard substrata, which would otherwise not be found on the natural sandy substrates prevailing in Belgian waters (see chapter 6, partim North Sea).

The Belgian marine area is part of the most southern section of the North Sea. It stretches out in front of the coast for about 100 km and has a surface of almost 3,500 km^2, representing only 0.6% of the entire North Sea surface. Its position in the Channel nevertheless gives it a strategic and economical significance at worldwide level. The sea bottom is essentially covered by sands presenting a relief of banks and channels.

3. Soil

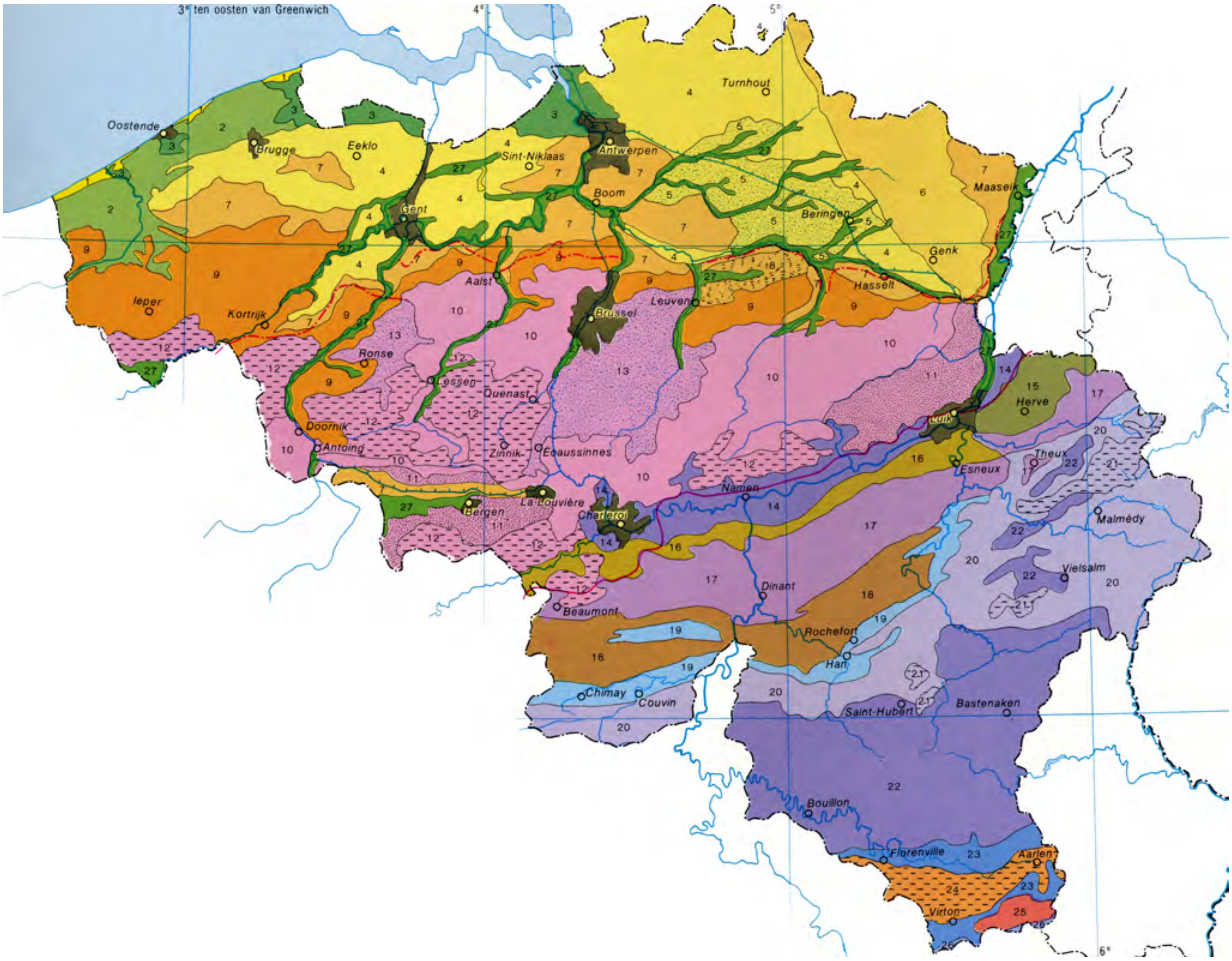
There are many definitions of the term ‘soil’, depending on the field of interest. Most simplified, the soil or pedosphere corresponds to the upper part of the lithosphere (all rocks and sediments) where the atmosphere (mainly precipitation, temperature and wind) interacts with the biosphere (flora, fauna, man). This subchapter focuses on soil aspects with a direct impact on the distribution of plants and animals. From this point of view, soils are regarded as an essential element among the abiotic factors in the ecosystem dynamics. Considering the depth that tree roots and some burrowing animals may reach, information is needed down to at least 2 m. The term ‘soilscape’ refers to the soil types, and their distribution, occurring below the surface of the landscape. Figure 3 provides the distribution of soil types in Belgium. The numbers between brackets in the text refer to this map and its legend. Published at a scale of 1:1,500,000 by the Standaard Atlas, it was derived from the soil association map (Marechal & Tavernier 1970, 1974) of the Atlas of Belgium, edited at a scale of 1:500,000.

3.1. Major soil-geomorphic areas

In the description of the Belgian soilscape, 5 major soil-geomorphic units can be distinguished. For more information on the topography of these units, see subchapter 2.

Lower Belgium [1] includes the coastal dunes (1), polder area (2, 3) and the sand belt of Flanders and the Kempen (4 to 7). The relief is very flat and agriculture is the dominant land use feature.

[1] Belgium is sometimes divided into three regions based on altitude: Lower Belgium (up to 100 m above sea level), Middle Belgium (between 100 and 200 m), Upper Belgium (above 200 m).



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Distribution of soil types in Belgium (Atlas Mens en Aarde, Uitgeverij De Boeck, Antwerp). Only the dominant soil types are commented.

1. Slightly calcareous sandy soils of coastal dunes. Excessively drained on the dunes, poorly drained in the dune slacks (pannen). Half of the area under natural to semi-natural colonising vegetation.

2 and 3. Clayey to clayey sandy soils of the polders, mostly slightly calcareous. Groundwater table present within a depth of 1.2 m. Under intensive agriculture, mainly as cropland, partly as meadows.

4. Acidic sandy soils of the sand belt. West of the Scheldt, agriculture and drainage since the mediaeval period. East of the Scheldt, less pronounced human activities until World War II, except around villages. Since then, increased human impact following intensive crop growth, urbanisation and industrialisation. Locally, a few heathlands and mobile dunes remain.
5. Transition between the sand belt (4) and the loess belt (9 to 13).
6. Acid sandy soils developed on relict dunes. These dunes stabilised on Pleistocene Meuse river terraces (Kempen Plateau). A few preserved heathlands. Large areas reforested with pine tree plantations.
7. As 5: transition between the sand belt (4) and the loess belt (9 to 13).
8. Shallow loess soils on Tertiary sandy clay substratum.
9. Sandy silt facies of the loess belt, with water table.

10 and 11. Loess belt soils, without water table. Under agricultural pressure for many centuries.

12. Loess belt soils, with water table. Under agricultural pressure for many centuries.
13. Association of loess and sandy soils, without water table. Developed in loess on the smooth slope and plateau positions. Under agricultural pressure for a few centuries. Developed in Tertiary sand outcrops along the valley slopes, these areas were forested most of the time but are now under intensive urbanisation pressure. At the southeastern fringe of Brussels, a 40 km^2 forested area (Sonian Forest, not represented on the map) has never been used for agricultural purposes. Grazing has always been severely restricted. This area is unique because it allows to observe the original geomorphology and soilscape of the West European loess belt before man started to clear the forest for agricultural purposes.
14. Slopes and valley bottoms of Meuse and Sambre river incisions. Very diverse soilscape due to landscape features such as valley slopes, Pleistocene terraces, Holocene alluvial plain, soil parent material and the strong human impact.

Middle Belgium is largely coinciding with the dominant loess cover (9 to 13) resting on Tertiary marine sediments that are mainly clayey or sandy and outcrop at particular landscape sites such as hill tops and west, southwest and south-facing slopes. Except along the main river valleys, the relief is mainly smoothly undulating.

Upper Belgium hosts three important soil-geomorphic components, described here from northwest to southeast.

The **Condroz-Fagne-Famenne-Herve area** with altitudes from 200 up to 350 m. This area has still some patchy areas of loess cover, but most soils are developed on a high diversity of rock types including chalk, limestone, psammite and shale. The relief is moderately undulating (15, 16, 17, 19) except for the flat Fagne-Famenne depression (18).

The **Ardenne massif** (20 to 22) with smoothly undulating plateaus intersected by deep incising valleys. Soils are dominantly derived from weathering products of acid rocks such as sandstone, shale and slate. Crop growth is restricted, mainly because of the relatively low air temperature regime inducing a too short growing season.

The **Belgian Lorraine** (23 to 25) with altitudes between 200 and 465 m and a cuesta landscape belonging to the Paris Basin. Soils are developed on a very wide variety of sediments and rocks including loess, calcareous sandstone, limestone, marl, etc.

3.2. Factors of soil formation

The diversity of present-day soil types is mainly the result of nine environmental factors, briefly commented below.

15. Herve Plateau. Loess soils with substratum of Cretaceous chalk, weathering clay and Primary shales at variable depth.
16. Northern fringe of the Condroz. Loess soils on Primary sandstone and shales. Forests in the areas with water table, cropland on the better-drained areas.
17. Condroz. Moderately rolling landscape with very diverse soil types: thin loess cover on Primary limestone and psammite at variable depth, scattered patches of deep loess soils on plateau areas with limestone substratum. Very diverse land use with cropland, meadows and forests according to slope and soil composition.
18. Fagne-Famenne depression with shallow silty and clayey soils on weathered Primary shales. Mainly forests and meadows.
19. Southern fringe of the Fagne-Famenne, or Calestienne. Shallow silty soils on limestone. Cropland on the deeper soils, forests on the shallow soils.
20. Northern half of the Ardenne massif. Silty stony soils on Primary rock substratum of shales and sandstones, mostly without water table. Forests on the slopes and where the rock occurs at shallow depth. Meadows around villages in areas with the thickest silty soils on the plateau areas.
21. Plateau peat bogs and surrounding silty soils with groundwater stagnation on the clayey weathered rock substratum (saprolite). Locally traces of periglacial (Weichsel Late Glacial) ice mounds. Some peat bogs are still open landscapes with *Sphagnum* mosses and sedges. Others were quarried up to the mid 20th century, or were drained and planted with coniferous trees.
22. Southern half of the Ardenne massif. Silty stony soils on Primary rock substratum of shales and slates, without groundwater. Soil distribution and land use as under 20, except some cropland towards the south.
23. Belgian Lorraine. Clayey soils with internal drainage problems on Jurassic marls. Dominantly meadows, some deciduous forests.
24. Belgian Lorraine. Soils on limestone and calcareous sandstone, without groundwater. Some loess soils on plateau areas. Dominantly under deciduous forest, some cropland.
25. Belgian Lorraine. Soils on calcareous sandstone (macigno), without groundwater. Cropland, forest and meadows.

The **soil parent material** (rocks and sediments) in Belgium is rather diverse. Three major units cover each at least 20% of the country: firstly the quartzitic sands (1, 4, 5, 6) of Lower Belgium, secondly the loess belt of Middle Belgium with dominant silty and sandy silt textures and about 15% clay (7 to13) and thirdly the silty soils on acid rocks such as siliceous sandstone, shale and slate in the Ardenne massif (20 and 22). Besides these large units, soils developed on calcareous clayey tidal flat (2, 3) and alluvial (27) sediments, on chalk (15) and marls (23), on Tertiary marine outcrops ranging from quartzitic sands to glauconic clays (in areas 4 to 13), on hard rocks such as limestone (17, 19), shale (18) and sandstone that can be micaceous (17), calcareous (24, 25), ferruginous and siliceous (25, locally 5 and 8).

Duration of the period over which the landscape is stable, or 'age' of the soil. The Belgian soilscape is rather 'young'. Soils on the coastal dune ridge (1), the polder areas (2, 3) and alluvial plains (27) are younger than 1,000 years. The end of the original Weichsel Pleniglacial and Late Glacial sand and loess deposition of North and Middle Belgium (4 to 13) dates back to 10,000-15,000 years. Since then, anthropogenic erosion and sedimentation have rejuvenated a large part of the soils in these areas. The large soilscapes developed on Tertiary (scattered in 4 to 13), Secondary (15, 23 to 26) and Primary (16 to 22) sediments and rocks were significantly renewed by Weichselian erosion processes. Anthropogenic erosion and sedimentation processes have further strongly rejuvenated those areas of the sand (4 to 7) and loess (8 to 13) belts that are since many centuries under intensive agriculture. Only in some karstic sinkholes (scattered in 17) and on part of the Ardenne plateau (20, 22), deep saprolite can be observed reflecting long lasting weathering under a tropical climate and high soil surface stability during and since the Tertiary.

During the Bolling and Allerod stadials of the Late Glacial, and during most of the Holocene, the **climate** of the country presented an excess of precipitation over evapotranspiration for forested sites. Since forests have been cleared over large areas to create meadows and cropland, the precipitation excess increased markedly. As a consequence of this recharge-discharge balance, the whole Belgian soilscape, including the coastal dune area with the lowest precipitation, is losing plant nutrients through time. Where developed on calcareous sediments, such as the Pleniglacial cover sands and loess (4 to 13), or on calcareous rocks such as the Carboniferous and Jurassic limestones (17, 23 to 26), soils become gradually decarbonated and more acid. Soils can also have an impact on the (micro)climate: the coolest temperatures of Belgium, recorded in the peat bogs (21) of the Ardenne plateau, are slightly enhanced by the intensive evaporation from these large marshy, wind-swept areas.

The **topography** plays an important role in soil variability, mainly by three observed environmental impacts. Firstly, soils on south facing slopes warm up and dry out more and faster than those facing north. Secondly, during rainy periods, dominant winds come from the southwest. Consequently, the slopes oriented in this direction receive considerably more precipitation than slopes oriented towards the northeast. This difference in soil moisture regime has an impact on the leaching of nutrients, the acidification and the depth of decarbonation. On calcareous sandstone, or on loess deposits, it is not uncommon to observe a decarbonation occurring twice as deep on the southwest facing slopes in comparison with the northeast oriented slopes. Thirdly, when the land is bare, the risk for erosion by wind or water is considerably higher on southwest facing slopes than on northeast facing ones.

Soils have a direct impact on plant growth. But **vegetation** has also an impact on soils, among others by:

- the quality of the litter input (e.g. deciduous and coniferous trees will produce different types of humus);
- the evapotranspiration of the ecosystem, influencing the amount of excess water percolating through the soil;
- the organic matter input in the soil surface horizons, increasing aggregate stability and potential for nutrient and water retention;
- the feed-back of nutrients to the surface horizons by the litter and to the deeper soil horizons by the input of substances from the roots.

One neglected impact of plants on soils is the uprooting of trees. This process increases markedly the ecosystem diversity. In Lower and Middle Belgium (4 to 13) about 10% of the soilscape has been influenced by this process down to at least 80 to 100 cm depth. Another human-induced feature is the development of heathlands due to sheep and cattle grazing since the Bronze Age. Heath vegetation accelerates soil acidification (4 to 6). A third example of anthropogenic impact by vegetation on soils is the plantation of extensive pine areas in the sand belt (4, 5) and spruce and Douglas fir in the Ardenne (20 to 22). These are responsible for an impoverishment of the soil fauna and flora and create a risk for increased release of aluminium in the groundwater with a possible impact on the river water quality.

The herbivore **fauna** has an important influence on acid soils. Consumption of the ground vegetation and straw and the input of dung and urine, decrease the carbon/nitrogen (C/N) ratio in the soil surface horizons. Besides this direct impact on the chemical soil fertility, there is also a very important effect on the physical soil fertility. Parallel to the input of dung and the lowering of the C/N ratio, an increase of the scarabid and earthworm populations is observed. In a second phase, these burrowing animals attract the presence of insectivores such as moles. All these animals drill galleries in the soils and thus favour aeration, water percolation and deep root penetration. These processes are strongly hampered in many soils that have undergone no human impact such as organic or mineral fertiliser applications or bringing grazing animals in forested sites. The most intensive and deepest faunal turbation by earthworms and moles is observed in the polder areas (2, 3), those loess soils (7 to 13) that are under pastureland and the soils on chalk (15), marl (23) and limestone.

Since centuries, North and Middle Belgium are among the densest populated areas in the world. Evidently, the impact of **man** on the soilscape is very important. Today, very few areas allow to have an idea how the soilscape would have been, if human presence had been restricted to hunters/gatherers in these areas. A few forested sites that have undergone little or no grazing activities are from this point of view unique for earth science and should be protected from further human disturbance. The Sonian Forest, situated in the loess belt at the south eastern edge of Brussels, is such an area (not represented on the map). Here, soils display the very acid and the low physical fertility conditions that the first farmers were facing some 7,000 years ago, when they made a first tentative in colonising the West European loess belt. These areas allow the measurement and the evaluation of human impact on the remaining 99% of the soilscape in North and Middle Belgium. Deep ploughing, intensive fertilisation, soil levelling and drainage, and the associated erosion and sedimentation processes have been the main activities responsible for a profound change in morphological, physical and chemical soil characteristics in Lower and Middle Belgium. In Upper Belgium, this impact has been much less important. However, it is difficult to find areas on the Ardenne plateau where shifting cultivation, drainage works or cattle grazing have been absent.

Another factor influencing soil formation is the **soil moisture regime**. Well-drained soils dominate the Belgian soilscape. When crops are grown, such soils do not have to be drained or irrigated. Despite a considerable precipitation deficit in summer, plants will not reach wilting point because of a groundwater table within rooting depth in sandy soils, or because of the water-holding capacity of the clayey or silty soils. The driest soils of the country are found in the coastal (1) and inland (scattered in 5 and 6) dune areas of Lower Belgium and on some of the Tertiary sandy outcrops (scattered in 13) of Middle Belgium. In these soils without clay or silt, the drought is enhanced by the hydrophobicity of the humus-rich surface horizon and the dense packing of the sand grains in the deeper subsurface horizons. Intensive drainage operations have considerably lowered the groundwater table in the polders (2, 3), that were once tidal flat areas, in most of the original wetlands of the cover sand area (4 to 8), where the low position and the presence of a clayey substratum below the sand cover impede good drainage, and finally in that part of the loess belt with a clayey substratum (9, 12). Some of these drainage works date back to the mediaeval period. Later, in the first decades after World War II, they became very intensive in the frame of land reclaim projects. The purpose was to facilitate the growth of winter crops and to make the land accessible to heavy engines in early spring in order to extend the growing season for summer crops.

Today, the few remaining wetland soils are scattered throughout the country. Most of them are situated in the alluvial plains (27) or dispersed in small parts of the cover sand area (mainly in 4 to 6). Most of these areas are still under threat of surrounding drainage works that locally penetrate the alluvial plains in order to grow crops. Peat soils covered originally rather extensive areas of the sandy lowlands (4 to 6) and the alluvial plains (27). The extent of these soils has dramatically decreased because of intensive peat exploitation for fuel and drainage works to enhance crop grow. The drainage process has led to an accelerated decomposition of the organic matter and a lowering of the soil surface reaching 1 to 2 cm per year. Large part of the upland peat bogs on the Ardenne plateaus (21) have also been quarried for fuel production and have been drained for coniferous tree plantations.

In Belgium, erosion processes would be almost inexistent if there was no human interference. In naturally forested sites, all precipitation water infiltrates into the soil and no surface runoff is observed. The most important ‘natural’ **erosion and sedimentation processes** were landslides on slopes with clayey soils (15, 23) and on scattered hills with Tertiary clay outcrops in Lower Belgium. Under ‘natural’ conditions, similar processes could take place in the alluvial plains (27), on the tidal flat areas (2, 3), along the coastal beach fringe (1) and along the rock cliffs of Upper Belgium where some slope debris deposition occurs. The rest of the soilscape would be completely stable since at least the beginning of the Holocene. After a first clearance of the forest for agricultural purpose by the early Neolithic farmers, some 7,000 years ago, accelerated erosion and sedimentation processes started. In the beginning, and probably up to the end of the Iron Age, the magnitude of these processes was rather limited. Even though agriculture intensified during Roman times, it is mainly since the mediaeval period that colluvial sedimentation has been observed on foot slopes and in depressions, together with alluvium sedimentation in the alluvial plains. The use of the plough that cuts, lifts and turns over the soil has certainly accelerated the erosion processes. Splash, sheet, rill and tillage erosion are the main processes taking place on croplands of the loess belt (9 to 13). Where these soils are under agricultural practice since many centuries (9 to 12), up to 30% of the soilscape may be composed of soils developed in metres thick colluvial deposits that gradually filled the depressions. In the sandy area of Lower Belgium, some aeolian erosion may happen on cropland or when overgrazing of heathland occurs.

4. Geology

Belgium has a rich geological history and it would take too long to make a detailed presentation of the geological structure of the country. This section will therefore concentrate on items relevant for biodiversity, namely the main lithological features of the major stratigraphic units.

Belgium is almost entirely made up of sedimentary rocks, showing a considerable age and composition diversity. Igneous and metamorphic rocks are much less represented. Igneous rocks appear only sporadically, such as in Lessine and Quenast, two villages in Brabant famous for their quartz diorite (or porphyry) found in old volcanic chimneys. Volcanic rocks sometimes occur between marine sediments. This is the case near Manderfeld on the Belgian-German border, where the most occidental of the recent Eifel volcanoes is found. Metamorphic rocks occur in some regions, for example in the Ardenne around Vielsalm, Bastogne and Libramont, but their metamorphic character is generally so weak that it is easy to recognise the properties of the sedimentary rocks from which they are derived.

The sedimentary rocks can be subdivided into four large stratigraphic units, corresponding to their age and structural position: the lower and upper Paleozoic folded units, the unfolded post-Paleozoic cover and the Quaternary cover.

4.1. Lower Paleozoic rocks

The rocks of the lower Paleozoic unit, the most ancient sedimentary rocks in Belgium, were deposited between 545 and 417 million years ago (Ma) following a major marine transgression. They are mostly of detrital marine origin, but some of them have a coastal or continental origin. Diagenesis and low-grade metamorphism transformed the unconsolidated sediments into coherent rocks, mostly sandstone, quartzite and shale. They were then folded and faulted during two different phases of the Caledonian orogeny, a major mountain-building episode of the lower Paleozoic era: an earlier phase took place in the Ardenne about 450-420 Ma and a later phase in the Brabant Massif about 410-380 Ma.

4.2. Upper Paleozoic rocks

The rocks of the upper Paleozoic unit were deposited between 417 and 290 Ma. They include detrital rocks but also marine limestone and continental coal. In the Ardenne, they were folded during the Variscan (or Hercynian) orogeny around 300-270 Ma and underwent low-grade metamorphism. In the northern part of the country, they are mostly lying unfolded on the southern and north-eastern edges of the Brabant basement, but they do show some faulting.

GEOCHRONOLOGY Ma					LITHOLOGY
	CENOZOIC	QUATERNARY	HOLOCENE		sand, loam, clay, peat, gravel
1,8			PLEISTOCENE		
		TERTIARY	PLIOCENE		sand
			MIOCENE		
			OLIGOCENE		clay, sand
			EOCENE		
			PALEOCENE		sand, calcarenite, marl
65	MESOZOIC	CRETACEOUS	UPPER		chalk, marl, calcarenite
			LOWER		
144		JURASSIC	MALM		
			DOGGER		
				BAJOCIAN	limestone
			LIAS		sandstone, marl
213		TRIASSIC	RHAETIAN		sand marl conglomerate
			KEUPER		
			MUSCHELKALK		
			BUNTSANDSTEIN		
248	PALEOZOIC	PERMIAN			shale (sandstone)
286		CARBONIFEROUS	SILESIAN	STEFANIAN WESTFALIAN NAMURIAN	shale (sandstone)
			DINANTIAN	VISEAN TOURNAISIAN	limestone
360		DEVONIAN	UPPER	FAMENNIAN FRASNIAN	sandstone shale limestone
			MIDDLE	GIVETIAN COUVINIAN	limestone limestone, shale
			LOWER	EMSIAN SIEGENIAN GEDINNIAN	shale, slate (sandstone)
408		SILURIAN			shale, slate
438		ORDOVICIAN			
				TREMADOCIAN	slate
505		CAMBRIAN		REVINIAN	slate
590				DEVILLIAN	quartzite

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The stratigraphic timescale with indication of the corresponding lithology (from DENIS 1992, courtesy of Dexia).

The Paleozoic bedrock emerged as a platform after the Variscan orogeny and is at present exposed all over Upper Belgium (south of the Sambre and Meuse axis), except in the Belgian Lorraine where it is covered by younger unfolded rocks. To the north of the Sambre and Meuse axis, the Paleozoic bedrock is uncovered only locally in the valleys of the Scheldt, Dender, Senne, Dyle and Gete.

4.3. *Post-Paleozoic cover*

The sediments of the post-Paleozoic cover date from the Mesozoic and the Tertiary. They were deposited between 225 and 1.8 Ma, and are generally of marine origin. As they have not been affected by any folding, they mostly kept their horizontal stratification and remained in a soft rock state (sand, clay, chalk). More or less coherent layers of limestone or calcareous and siliceous sandstone are inserted between them. North of the Sambre and Meuse axis, the total thickness of the post-Paleozoic cover increases gradually in a north to north-eastern direction: from 0 to 200 m in Middle Belgium, 200 to 500 m in Lower Belgium to more than 1,000 m in the north and north-eastern part of the Kempen. In the Haine Valley, the sediment deposits reach 200 to 400 m, while in the Belgian Lorraine they progressively increase from north to south, to exceed 700 m at the French border.

4.4. *The Quaternary cover*

The sediments of the Quaternary cover are very recent compared to those of the Paleozoic bedrock and post-Paleozoic cover: even though the beginning of the Quaternary has been fixed at 1.8 Ma, the sediments generally do not exceed a few tens of thousand years in Belgium. They are mostly of continental origin, except for some deposits in the coastal zone. The major part of the oldest Quaternary deposits has been removed by erosion. Only scattered remnants are found, except in the Kempen where the clay and sand deposits can be 50 m thick, and in central Belgium where an extensive loess cover dating from the Ice Age attains several metres. The thickness of the Quaternary cover is usually less than 1 m, but can reach exceptionally 30 to 40 m in some places. The Quaternary deposits are the thickest on the plateaus, gentle slopes and plains with a concave or flat relief. They are absent or discont-inuous on steeper slopes. The composition of the cover is extremely variable: clay, sand, silt, peat, gravel, etc. Abrupt changes in composition are mainly due to the local topography.

The Quaternary deposits are extremely important, as they constitute almost everywhere the superficial layer in which soils were formed and on which human activities take place. The subdivision of Belgium in natural regions also reflects the origin, composition and thickness of the Quaternary cover.

5. Climate

The Belgian climate can be summarised by two annual averages calculated for the Uccle weather station, at the headquarters of the Royal Meteorological Institute: a temperature of 9.8^{o}C and a precipitation of 802 mm. This corresponds to a mild, temperate, maritime climate with a relatively high average temperature and moderate precipitation for such a latitude (50^{o}). The south-eastern part of the country, especially the Hautes Fagnes, displays features of a slightly more continental and tougher climate, as illustrated below.

5.1. Precipitation

The annual precipitation measured in Uccle ranges between 406 mm and 1,082 mm, with an average of 802 mm. The lowest rainfall is observed near the coast, while it increases gradually inlands towards the southeast.

The predominant factor influencing the annual precipitation is the altitude: the higher the altitude, the more abundant the rainfall. Anomalies can be explained by the general orientation of slopes in relation to the progression of the main atmospheric disturbances: the south-western border of the Ardenne is much wetter than its central and south-eastern parts, which correspond to more sheltered zones. With annual rainfall normals varying between 1,100 and 1,400 mm, the Hautes Fagnes, near the German border, and the Plateau des Tailles, near the French border, also experience higher precipitations than expected by a higher altitude only. This is also the case to a lesser extent in the northern part of the country, such as in the Kempen near Antwerp, the Country of Waes and the surroundings of Eeklo and Ghent. On the other hand, the surroundings of Tienen, the north-eastern corner of Limburg, the Hesbaye, the Condroz and the area between Sambre and Meuse are characterised by lower precipitations than expected. These variations can partly be explained by the analysis of changes in rainfall distribution throughout the year.

The times of the year with the least precipitation in Belgium are generally the end of winter and the beginning of spring. The periods with the most abundant precipitations differ from one region to another. The coastal zone experiences a simple pattern with maximum rainfall in autumn, while the most southern part of the country shows a maximum in winter. These maxima both demonstrate a maritime influence: the autumn maximum at the coast corresponds to North Sea maritime features, whereas the winter maximum in southern Belgium relates to oceanic influences (such as seen in Brest, France). Between these most distant areas, the different rainfall zones show a complex regime where an aestival rainy period appears in addition to the two peaks cited above. This feature, typical of more continental climates, may even dominate in some areas, as for example in the Hautes Fagnes.

5.2. Temperature

The average temperature from 1901 to the present day is 9.8^{o}C in Uccle. Nearly 10^{o}C is actually a mild temperature for a latitude of 50^{o}: this average is similar to stations in southern England and Ireland, but much higher than what is observed on the Russian east coast (2^{o}C in Petropavlovsk, Kamtchatka) and somewhat higher than averages from Canadian or Argentinean coastal towns of comparable latitudes (8^{o}C in Port Hardy and Santa Cruz). The mild temperatures occurring in Belgium are related to the influence of the Gulf Stream, which tempers the air masses in winter. Particularly wet or dry years can most often be correlated to the character of their summer or autumn, whereas years with abnormal average temperatures are principally controlled by the harshness or mildness of their winter months.

Like for precipitation, the principal factor regulating the spatial distribution of average temperatures is the altitude (cooler temperatures with higher elevations). Again, the gradient does not remain constant from one month to another. The average cooling rate per 100 m of altitude is higher in winter than in summer, both for maximal and minimal temperatures. Other factors intervene besides altitude. For example, the proximity to the coast influences somewhat the maximal temperature (but not the minimal temperature); the effect of the North Sea and Zeeland can be felt up to 30-40 km inland, especially from April to August. Topography also plays a role: temperature extremes are less correlated to altitude during the summer, when stations react in function of the local site configuration and land use. Valleys are cooler during the night and warmer during the day, while urban areas are warmer both during day and night.

Table 1. Some regional characteristics of the Belgian climate. The empty boxes indicate normal values in relation to the altitude or information gaps.

Area	Annual rainfall (*)	Period of maximum rainfall	Maximum summer temperature (*)	Wind speed	Sunshine
Coastal region (40 km inland)		autumn	very low	quite high	high
Country of Waes, western Kempen	excess	summer (autumn)	low		
Inland Flanders, Middle Belgium (Hainaut, Brabant, eastern Kempen)		summer, autumn, winter	quite high		low
Liège area (Hesbaye, Condroz, Plateau of Herve)	shortage	summer (winter)			low
Sambre-Meuse axis, central Ardenne	shortage	summer, winter (minor changes)			
High plateaus of the Ardenne (above 600 m)	large excess	summer (winter)	low	quite high	
Southern Ardenne	large excess	winter			
Belgian Lorraine	shortage		quite high		high

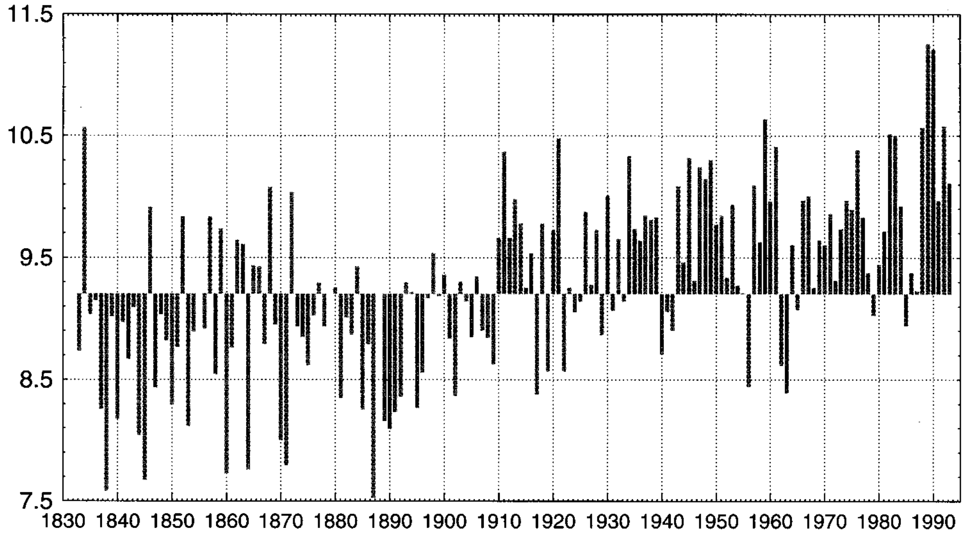
(*) Residuals from the regression in relation to altitude.

5.3. *Other climatic features*

Wind directions and velocities are particularly sensitive to the local environment of the recording station. As far as wind directions are concerned, it is difficult to identify specific patterns. Average wind velocities are highest at the coast and, to a lower degree, in a hinterland of about 40 km. Wind speeds are more moderate above central Belgium while they increase again further to the south, reaching another maximum on the high plateaus of the Ardenne.

Regional trends are difficult to establish for other climatic features such as the amount of sunshine, atmospheric humidity, cloud cover, mist, frost and snow cover. Some of these need complementary studies (e.g. snow) or even more adequate data collection (e.g. frost, atmospheric humidity).

Is Belgium experiencing a warming of its climate? This contemporary topic of interest must be handled with caution. Comprehensive data are available since 1833 only; moreover they may not be totally comparable as the network of observers and the recording methods evolved with time. Climatic records in Uccle show that a general warming of the climate has been observed in Belgium in the 20^{th} century, but that there have been no unusually warm years till the end of the 1980s. It should be noted that no significant changes have been observed for the rainfall.



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Average annual temperatures (°C) measured in Uccle from 1833 to 1993 (from Sneyers & Vandiepenbeeck 1995, courtesy of the RMI).

Between 1971 and 1987, the annual average temperature exceeded the 10°C barrier only three times, with a maximum value of 10.5°C in 1982 and 1983. But then a particularly warm period started: since 1988, with the exception of 1996 (9.1°C), the annual average temperature always exceeded 10°C, with maximal values of 11.3°C in 1989 and 11.2°C in 1990 and 2000. 1989 was the hottest year since the beginning of observations. The average annual temperature for 1988-2001 is 10.7°C. This may support the idea of climate warming, but conclusions in this matter should however be drawn extremely carefully.

Ecosystems around the world are showing the effects of climate warming. Four types of changes are possible (Root *et al.* 2003): the geographical range of species may shift, the timing of events (phenology) may change, changes in morphology and behaviour may occur and genetic frequencies may shift. Examples include the migration of species towards the poles or up in elevation, the earlier arrival of migrant birds, earlier appearance of butterflies, earlier spawning in amphibians or egg laying in birds and earlier flowering of trees and plants.

These phenomena are also observed in Belgium. Climate warming could, at least partially, explain the expansion of some Mediterranean species in a northern direction, in a way that their new distribution area encompasses Belgium or a part of it. A well-documented example in Belgium is that of southern dragonflies, observed regularly in Wallonia for the past ten years (Goffart & de Schaetzen 2001). Other Mediterranean insects have been recorded in Belgium, among others Orthoptera (crickets and grasshoppers) and Hymenoptera (bees, wasps, ants, etc.). Outside the world of insects, examples are also reported among spiders (*Argiope bruennechi*) and birds (European bee-eater, *Merops apiaster*).

The increase in the number of southern species reproducing in Belgium could be seen as a positive contribution to Belgian biodiversity. However, this might be overly optimistic, as the decline of species with a more northerly distribution has also been observed. Such a rarefaction has for example been recorded for dragonfly species found in peat bogs in the Kempen and Ardenne (Goffart & de Schaetzen 2001). Moreover, as current climate changes are very rapid, many organisms are not able to change their distribution patterns as fast as dragonflies, either because of lower dispersion abilities or because of the lack of suitable relay habitats allowing an easy retreat to the north. If temperatures rise further, northern species are predicted to decline significantly as they will disappear from the southern margins of their ranges, with little opportunity to expand northwards.

6. Evolution of the Belgian landscape

6.1. A wilderness

The recent origin (on the geological time scale) of the Belgian landscape is largely the result of changing climate and vegetation patterns over time. The Quaternary has been marked by an alternation of glaciations and warmer periods, with considerable changes in the fauna and flora as a consequence. During the coldest episodes, a thick ice mantle covered most of northern Europe (Ireland, Wales, Scotland, northern England, Scandinavia) while Belgium experienced a periglacial climate, with many cold spells briefly interrupted by warmer periods. The landscape, open and apparently lacking in trees, was dominated by a steppe vegetation. The last glaciation ended about 10,000 years ago, giving place to the current interglacial period.

The gradual warming up of the climate after the last glaciation allowed the development of an almost continuous forest cover from the coast to the higher areas of the Ardenne. This cover was actually made of a series of different deciduous forest types, depending on the local soil conditions. It was interrupted only where tree growth could not take place: on emerging rocky substrates, unstable soils such as dunes, regularly flooded areas such as marshes, peat bogs, etc.

6.2. Forest clearance

The introduction of agriculture and the successful establishment of farming communities around 5,200 B.C. marked one of the most significant transformations of the landscape in northern Europe. Neolithic farmers first started clearing the forests located on the best soils, in the alluvial plains of the large river valleys, the limy plateaus and sandy areas. Later on, they progressively carried out their expansion to less fertile regions of the Ardenne and Flanders. During the Middle Ages, the uninhabited landscape still dominated over the inhabited countryside and large forest areas occupied most of the space. Between the end of the Middle Ages and the 19th century, the landscape became progressively more open, with a combination of cultivated fields, pastures and forests. The forest cover decreased substantially around towns and villages, always in need of more wood for construction and economic development.

Until the industrial revolution, and even far beyond for some areas, the traditional agro-pastoral economy resulted in well-individualised, stable and harmonious landscapes. From a biological point of view, the opening up of the primeval forest coupled to recurrent land uses led to the diversification of the fauna and flora and to their combination into original communities, often of a very high biological richness. These forest-derived secondary communities, still present nowadays, are considered as semi-natural landscapes. They include calcareous grasslands, heaths and unfertilised hay meadows (which then occupied vast areas). Secondary semi-natural forests correspond for example to oak-birch forests that replaced beech forests in the Ardenne. Forests only slightly modified by human influence, both in terms of structure and composition, are considered as sub-natural. The habitats least influenced by man, and the most natural still found in Belgium, are those of primary dunes, salt meadows, peat bogs, marshes, rocky vegetation and aquatic fringes. All these environments described as natural, sub-natural or semi-natural, in function of the level of human influence, can be considered as natural in the broad sense since their characteristics are favourable to wildlife. Obviously, the same considerations cannot be applied to intensive agricultural, urbanised and industrial environments.

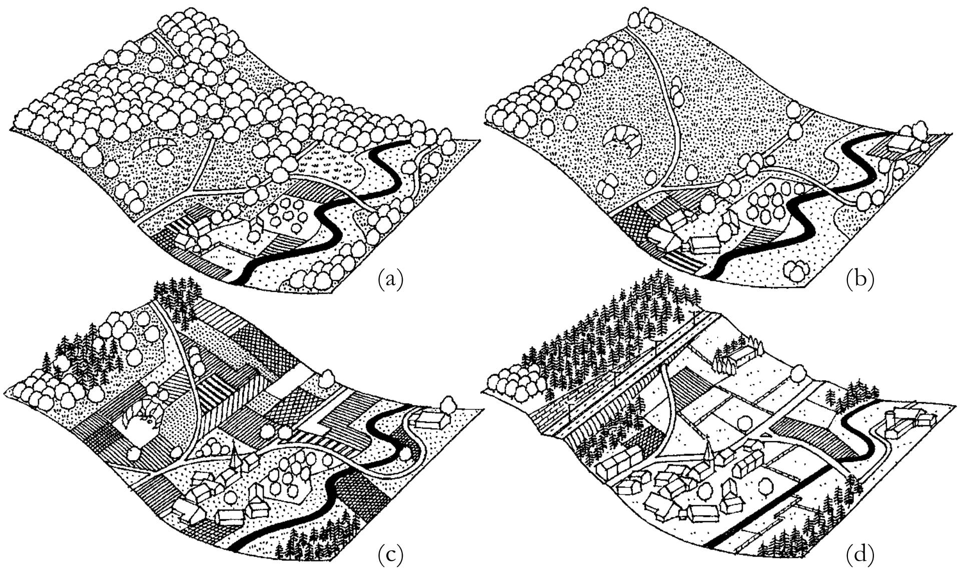
6.3. Transformation of the rural landscape

The industrial revolution led to major changes in the landscape. The country became more industrialised and urbanised. Early in the 19th century, the industrial axis of the Sambre-Meuse-Ruhr was formed, heralding the big conurbations of today. From the 1950s onwards, cities expanded and urbanisation slowly munched through the countryside. Housing developments surrounded small villages, while industrial estates spread along major roads and railways, with as a result the increased fragmentation of natural habitats. This is still the case nowadays.

Improved farming methods led to the intensification of agriculture, with increased pressure on the environment as a consequence. Until World War I, traditional agricultural practices were favourable to the development of biological and ecological elements of high value playing a decisive role in the ecological structure of the landscape. This was also the case for other traditional, sometimes semi-industrial, practices such as the exploitation of reed beds and peat extraction, which resulted in highly diversified landscapes with a well-marked regional identity and a considerable biological value. Biologically rich ecosystems developed and remained present on land marginal for agriculture (dunes, calcareous grasslands, dry and wet heathlands, marshes, peat bogs, etc.).

The industrial revolution accelerated the development of agriculture, with severe consequences for the ecological structure of the landscape. The first changes came with the increased use of fertilisers. Later on, mechanisation, an easier access to fossil energies, the modification of farming methods, the changeability of world markets, and, since the 1950s, the common agricultural policy in Europe, all contributed to the fast disappearance of traditional agriculture, the intensification of production and the levelling of landscapes. The regrouping of land parcels led to the disappearance of important landscape features such as hedges, ditches and ponds. Moreover, biologically rich marginal agricultural lands were either developed intensively through the use of fertilisers or, if their exploitation became economically unviable, set aside for afforestation (or reforestation) with exotic conifer species like Scots pine (*Pinus sylvestris*) in the Kempen and Norway spruce (*Picea abies*) in the Ardenne.

Together with urbanisation, major public works like the construction of highways and the straightening of waterways, and the increase in domestic and industrial pollution, agriculture has had disastrous effects on the survival and quality of natural habitats. This impact has been particularly severe in northern and central Belgium, prominent agricultural regions, where the ecological and agricultural characteristics of the landscape were transformed in a drastic way. In Upper Belgium, where the forest cover has always been more important, changes in the landscape affected the nature of the wooded areas, through the generalisation of plantations of exotic tree species. Here also, marginal agricultural areas underwent severe decline.



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Evolution of a typical landscape in the Ardenne: (a) situation in the 18th century, (b) in the 19th century, (c) at the end of the 19th century, (d) today (drawing by A. Froment, courtesy of Dexia).

7. People and society

7.1. Population

With a current population estimated at 10.3 million inhabitants (2002), Belgium is a very small country at the European level. However, with 338 inhabitants/km^2, it is the second most densely populated country in the European Union after the Netherlands (465 inhabitants/km^2).

The spatial distribution of the population underlines the unequal distribution over Belgium's territory. The most densely populated areas are found in a central rectangular area between Antwerp, Leuven, Brussels and Ghent. Other areas with a high population density (more than 300 inhabitants/km^2) are found along the Sambre and Meuse axis, around Kortrijk and along the coast. At the opposite, most areas south of the Sambre and Meuse axis do not exceed 50 inhabitants/km^2.

Belgium is a heavily urbanised country. There are 17 urban areas with more than 80,000 inhabitants, which gather 60% of the population on one fourth of the territory. Five cities exceed 100,000 inhabitants: Brussels, Antwerp, Ghent, Charleroi and Liège.

7.2. *Economy*

Thanks to its central position, Belgium is at the heart of the economic activity of the European Union. Even if it hosts only 0.2% of the world's population, it is the tenth exporter of goods (3% of the world market). Regarding services, Belgium comes in eight position (3.6% of the world market). Belgium is also a major transit zone in Europe, with 20% of the EU road transport carried out by Belgian transporters and with Antwerp as the second port in Europe after Rotterdam. Belgium also beneficiates from the presence of the headquarters of European institutions in Brussels, such as the Commission, the Council of Ministers and the Parliament. Other international organisations such as NATO are also established in the capital.

In 2001, Belgium's gross domestic product (GDP) totalled 263 billion EUR, which represents 2.9% of the EU total GDP. Long-term growth calculated for the past ten years averages 2.1% a year. The economy is dominated by the service sector and, while the manufacturing industry continues to contribute about 25% of the total GDP, its share of GDP is declining while that of the service sector continues to grow. In 1999, the Belgian GDP was distributed as follows: 1.3% for agriculture, 24.7% for industry and 67.1% for services. It should not be forgotten however that most services in the private sector are closely linked to industrial activities, among others for transport, adverting, financial services, engineering and maintenance. In 1999, Belgium exported goods and services to 76.5% of its GDP, with imports amounting to 73%. The main markets for exports were the other countries of the European Union, mainly Germany, France and the Netherlands.

7.3. *Agriculture and fisheries*

Modern agriculture bears little resemblance with traditional practices. As exposed earlier, the agricultural world has undergone significant changes in the 20^{th} century. However, even though agriculture currently occupies less than 2.5% of the active population, it remains an important economic sector not only for food supply but also because its activities extend over half the Belgian territory and shape the evolution of the rural landscape.

The major agricultural activities are arable crops and livestock production. Crops include cereals (about 500,000 ha in 2001), sugar beet (95,000 ha), potatoes (60,000 ha), rapeseed and linseed. Vegetables, fruits and flowers are other significant economic activities. Livestock production is mainly centred on cattle (both meat and milk), pig and poultry.

In 2001, there were less than 60,000 farms in Belgium while in 1970 there were 184,000. Their productivity and average area have increased, the latter reaching nearly 20 ha nowadays as compared to 8 ha in 1970. There are major differences between regions: Wallonia, with more extensive livestock production and crop cultivation, has bigger farms than Flanders, where intensive agriculture predominates (e.g. horticulture and intensive livestock rearing with no natural grazing).

Because of the limited coastline (66 km), fishing is not a major activity in Belgium. Only about 20,000 tons of fish (mostly flat fish and cod) are brought ashore by Belgian fishermen each year. Other marine products are shrimp and oysters. Zeebrugge, Ostend and Nieuwpoort are the three ports concerned by fishing activities.

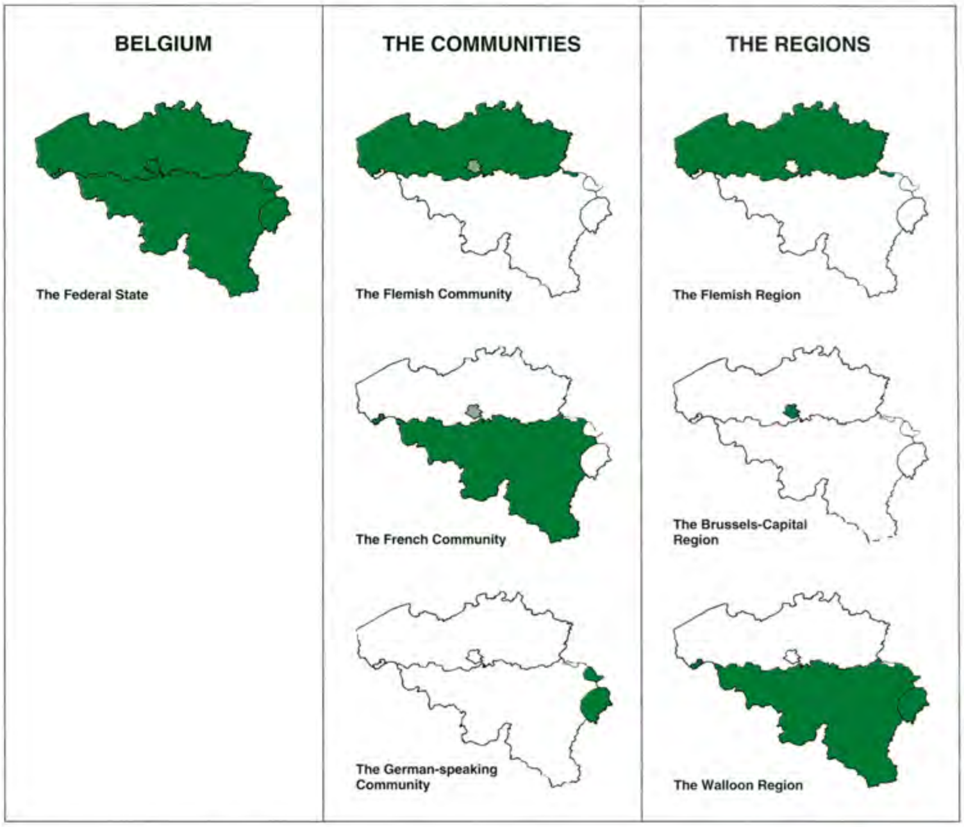
8. A federal state

Belgium has existed in its present form since 1830, when the Southern Netherlands (now Belgium) gained their independence following a revolution that separated them from the Northern Netherlands (now the Netherlands). During 140 years, Belgium remained a unitarian state with a decentralisation of responsibilities to the provinces and municipalities. Via four successive phases of institutional reform in 1970, 1980, 1988-89 and 1993, the country evolved progressively into a federal state. A fifth reform is currently envisaged. The redistribution of the decision-making power followed two lines:

(1) The first concerned linguistics, and more broadly, everything related to culture. It gave rise to three communities, based on language and related to population groups: the Flemish-, French- and German-speaking Communities.
(2) The second main line of the state reform was inspired historically by economic concerns and led to the founding of three regions corresponding to geographical entities: the Flemish Region (or Flanders), the Brussels Capital Region and the Walloon Region (or Wallonia).

As a result, the first article of the Constitution states today: "Belgium is a federal state, which consists of communities and regions". To some extent, the Belgian regions are similar to the German 'Länder' or the Swiss cantons. The country is furthermore divided into 10 provinces and 589 municipalities. The current decision-making structure of Belgium is therefore made of several levels: the upper level comprises the federal state, the communities and the regions; the middle level is occupied by the provinces and the lower level is that of the municipalities. The provinces and municipalities act within the framework of competences at the federal, community or regional level. The federal level, regions and communities each have their own government and parliament, giving Belgium a very distinct and unusual character.

The **federal level** remains responsible for everything that falls within the sphere of the national interest: foreign affairs, defence, justice, finances, social security, important sectors of public health and domestic affairs. The regions and communities are entitled to run foreign relations themselves in those areas where they have competence. The **communities** deal with matters relating to the people composing them: culture, education, radio and television, uses of languages, welfare for individuals, etc. The **regions** have authority in territorial matters such as regional development and town planning, environment, agri-



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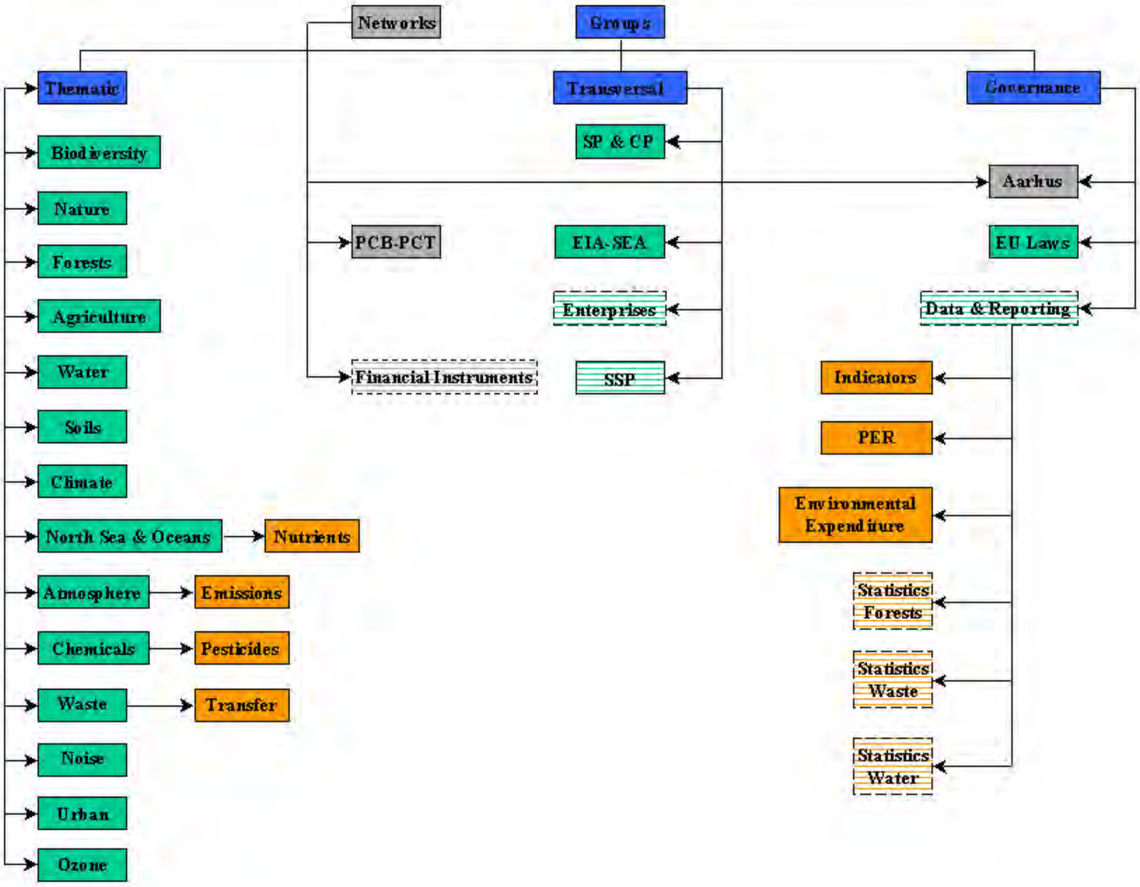
Belgium, a federal state consisting of communities and regions (drawing by H. Van Paesschen, based on a web-published map on http://www.belgium.be).

culture, rural development and nature conservation, energy, housing, water policy, employment, public works, transport, economic policy, regional aspects of banking policy and foreign trade. Implementation of nature and biodiversity conservation measures is therefore nearly entirely a regional competence.

Due to the complex organisational structure, decisions regarding international aspects of environmental policy are taken as a consensus between the different decision-making levels. The consultation process takes place through the Co-ordinating Committee for International Environmental Policy (CCIEP), which is composed of representatives of all the competent federal and regional administrations. This body functions under the high level authority of the Inter-ministerial Conference for the Environment (ICE), chaired by the Federal Minister for Environment. The main tasks of the CCIEP are to prepare for the positions of the Belgian delegations in international conferences and to organise consultation processes to establish a co-ordinated execution of international decisions and recommendations.

Several thematic steering committees operate under the authority of the CCIEP. Two of these are the steering committees ‘Biodiversity Convention’ and ‘Nature’. The steering committee ‘Biodiversity Convention’ is specifically in charge of the follow-up of the

Convention on Biological Diversity (CBD). Its tasks include among others the establishment of Belgian positions and the undertaking of reporting obligations. The steering committee 'Nature' carries out the follow-up of other international agreements such as the Convention on Wetlands (Ramsar Convention), the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) and the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention). It is also in charge of the co-ordination between regions regarding the European Union Habitats and Birds Directives.



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Organisation chart of the Co-ordinating Committee for International Environmental Policy (adapted from the original version). Green box: Steering Group; yellow box: Working Group; striped box: new situation; SP & CP: Sustainable Production & Consumption Patterns; EIA-SEA: Environment Impact Assessment / Strategic Environmental Assessment; SSP: Strategic and Structural Policy (including integration and sustainable development); PER: Pollutants Emissions Register; Aarhus: follow-up of the Convention on access to information, public participation in decision-making and access to Justice in Environmental matters; EU Laws: follow-up of the transposition process by legislative & administrative authorities in the field of environment & chemicals regulations, directives and decisions.

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