2007

Be down to earth: protect the soil of Europe

THE SOIL TYPES OF EUROPE

EUROPEAN COMMISSION
DIRECTORATE-GENERAL
Joint Research Centre

European Soil Bureau Network

Protecting soil in the European Union

(EM)

Soil is one of the fundamental components for supporting life on the planet.

Soil can be defined as a mixture of rock particles, organic matter, air and water that occupies the uppermost few metres of the Earth's crust.

Soil performs a number of key environmental, social and economic functions that are vital for life. Plants and crops are dependent on soil for the supply of water, nutrients and as a medium for growing. Soil stores, filters, buffers and transforms substances that are introduced into the environment. This capability is crucial in producing and protecting water supplies and for regulating greenhouse gases. Soil is a provider of raw materials. Soil is also an incredible habitat and gene pool – in excess of 5 tonnes of live organisms can exist in a hectare of arable soil. Soil is a fundamental component of our landscape and cultural heritage.

Simply put, without soil, the Earth and society as we know it, would not function. It is no coincidence that the word earth is used for both soil and the planet that we live on. In order to perform its many functions, soil condition must be maintained.

Soil biodiversity reflects the mix of living organisms in the soil. From top left, (clockwise) a bacterial colony (KR), a nematode (KR), a centipede (IB) and an earthworm (KR).

Yet, often the value of soil, a largely non-renewable resource, is not always appreciated.

The famous scientist, Gallileo said, *"What greater stupidity can be imagined than that of calling jewels, silver, and gold 'precious,' and earth and soil 'base'? People who do this ought to remember that if there were as great a scarcity of soil as of jewels or precious metals, there would not be a prince who would not spend a bushel of diamonds and rubies and a cartload of gold just to have enough earth to plant a jasmine in a little pot, or to sow an orange seed and watch it sprout, grow, and produce its handsome leaves, its fragrant flowers, and fine fruit"*.

Unfortunately, the careful use and management of soil has not been a high priority for many people. In fact, there is evidence that the thin layer of soil that we all depend on, in many areas of Europe and beyond, may be increasingly threatened by a range of human activities and climate change.

For this reason, the European Commission, supported by the Council of Ministers and the European Parliament, has agreed to develop a Thematic Strategy for the European Union to protect soil in the same manner as water and air.

The approach adopted by the Thematic Strategy is to ensure that soil is used in a sustainable manner so that future generations may inherit a viable environment and, if possible, find it in an even better condition that it is at present.

We hope that this calendar helps you to understand better how the product of the complex interactions between climate, geology, vegetation, biological activity, time and land use leads to the creation of the valuable resource known as Soil.

Soil characteristics can change markedly with depth. Colour differences reflect variations in the distribution of different materials. In the photograph below, a surface horizon containing high levels of decaying vegetation overlays a much paler horizon where the organic matter, aluminium and iron minerals have been leached (moved by water) further down the profile to form the dark iron-rich horizon. The sandy nature of the parent material is clearly evident at the base of the profile. The name for this type of soil is an Albic Podzol. Podzols are amongst the commonest types of soil in Europe and are often found in northern latitudes.

(MJ)

For more information on the European Union's Tematic Strategy for Soil Protecion, please visit: **http://ec.europa.eu/environment/soil/index.htm**

Leptosols

(from the Greek, *leptos*, meaning thin)

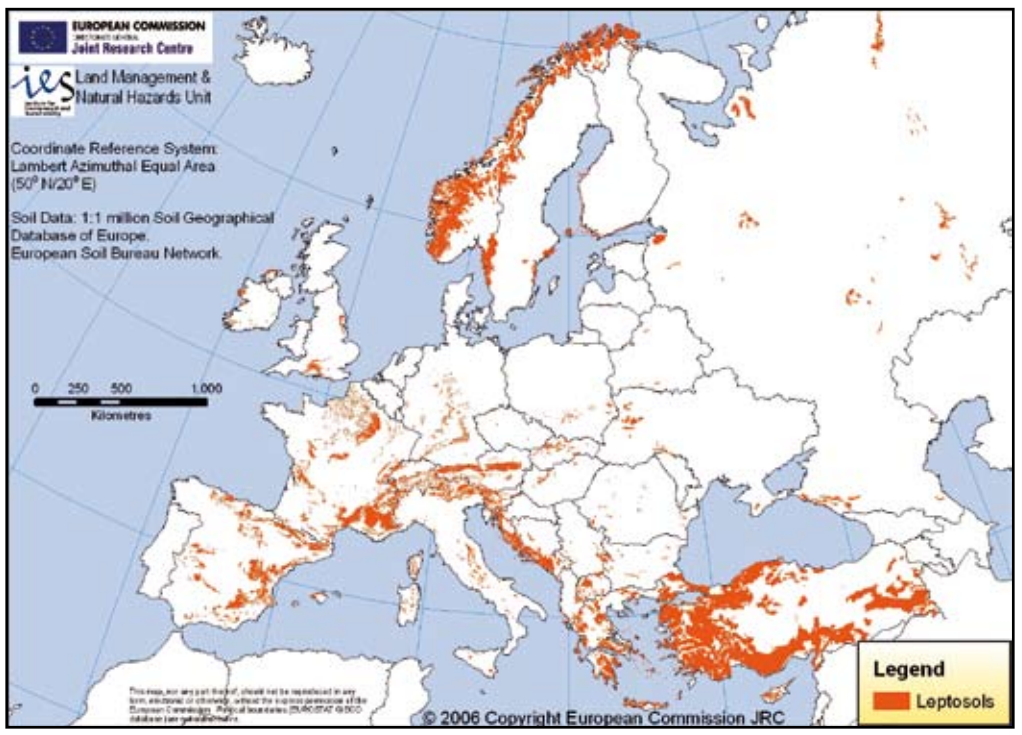
January 2007

(EM)

A Leptosol is a shallow soil over hard rock, very gravelly or highly calcareous (lime-rich) material. They are found mainly in mountainous regions and in areas where the soil has been eroded to the extent that hard rock comes close to the surface. Because of limited pedogenic (soil forming) development, Leptosols do not posses much structure. On a global scale, Leptosols are very extensive. Leptosols on limestone are commonly called Rendzinas while those on acid rocks, such as granite, are called Rankers. This profile comes from the Alps.

(EM)

In Leptosols, rocks are often close to the surface and many outcrops are visible. This is a view of Leptosols from Sicily.



Leptosols cover around 9 % of the surface of Europe and are found commonly in high altitudes and in the Mediterranean.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
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Histosols

(from the Greek, *histos*, meaning tissue)

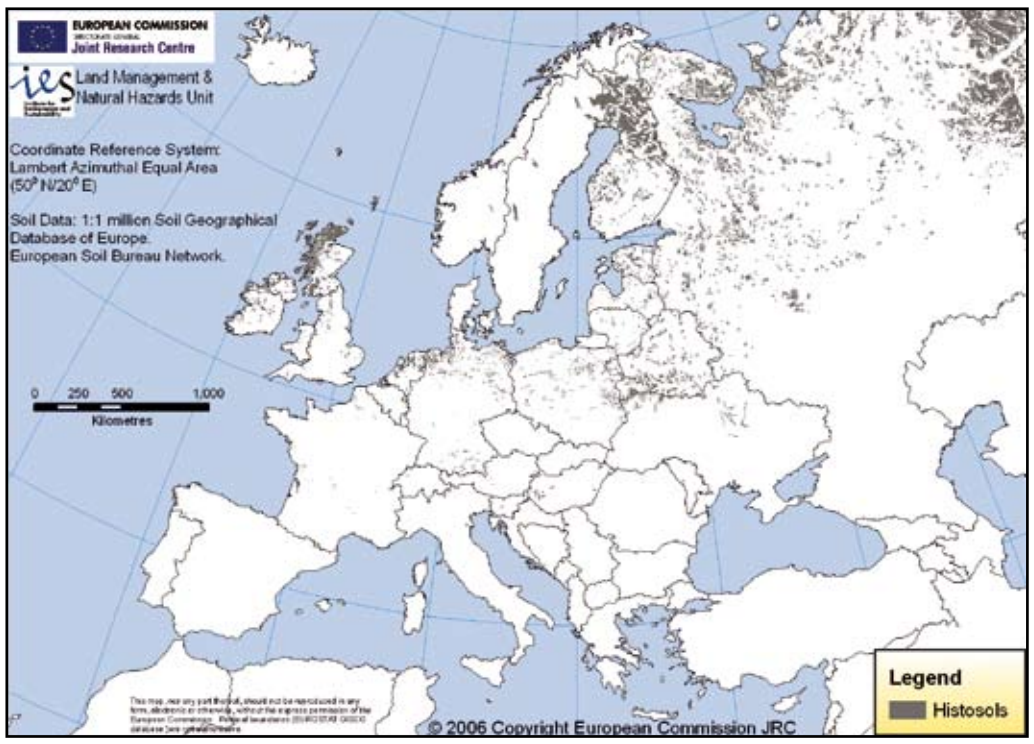
February **2007**

(EM)

Histosols are composed mainly of organic soil material. During formation, organic matter (mostly plant remains) production exceeds the rate of decomposition. Decomposition is retarded by low temperatures or low oxygen (anaerobic) conditions resulting in high accumulations of partially decomposed organic matter. Histosols are usually black or very dark brown and contain recognizable remains of plants. They are also known as “peat”, “muck”, “bog” and “organic soils”. This Histosol was photographed in Scandinavia.

(EM)

Histosols occur mainly in the boreal and sub arctic regions of northern Europe. The photograph shows a typical tundra landscape.



Histosols cover 5 % of the surface of Europe and are more common in northern latitudes.

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Gleysols

(from the Russian, *gley*, meaning mucky mass)

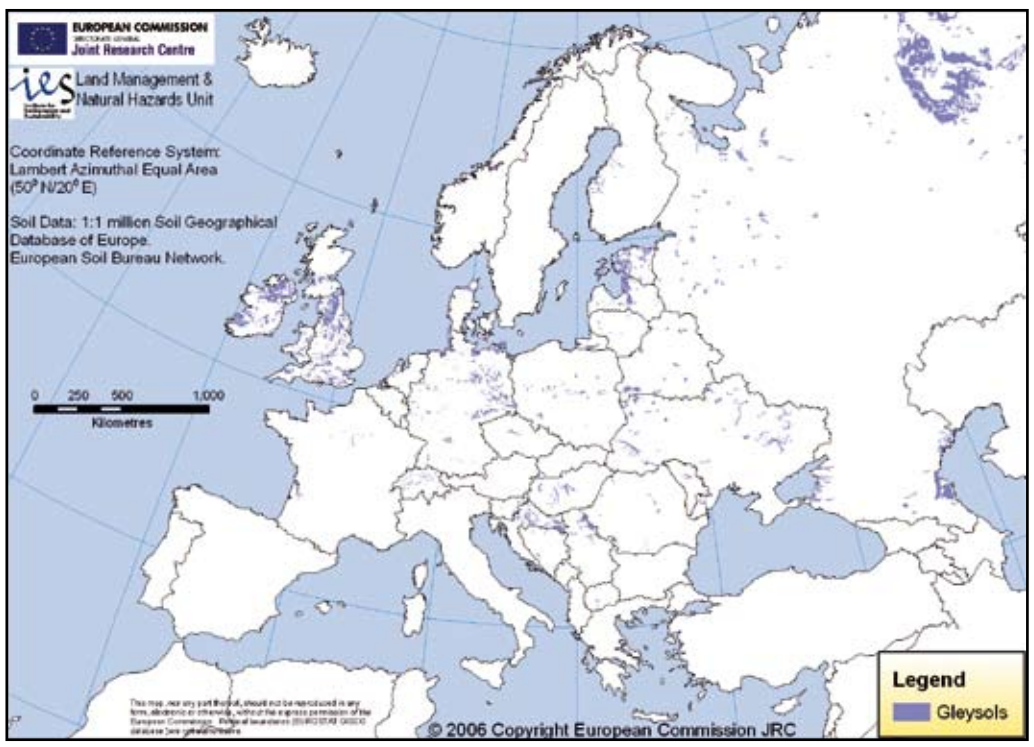
March 2007

(JK)

Gleysols occur mainly in lowland areas where groundwater comes close to the surface and the soil is saturated (the spaces in the soil are filled) with groundwater for long periods of time. Conditioned by excessive wetness at shallow depth, this soil type develops typical “gleyic” patterns made up of reddish, brownish or yellowish colours in the upper soil layers, in combination with greyish or bluish colours deeper in the soil profile. Common international names are Gleyzems (Russia), Gley (Germany), meadow soils, groundwater soils and hydro-morphic soils. This example comes from the Czech Republic.

(EM)

Gleysols are generally not well drained and need intensive management before they can be used. This meadow landscape comes from The Netherlands.



Gleysols cover nearly 4 % of the surface of Europe and indicate low-lying or poorly draining areas in the landscape.

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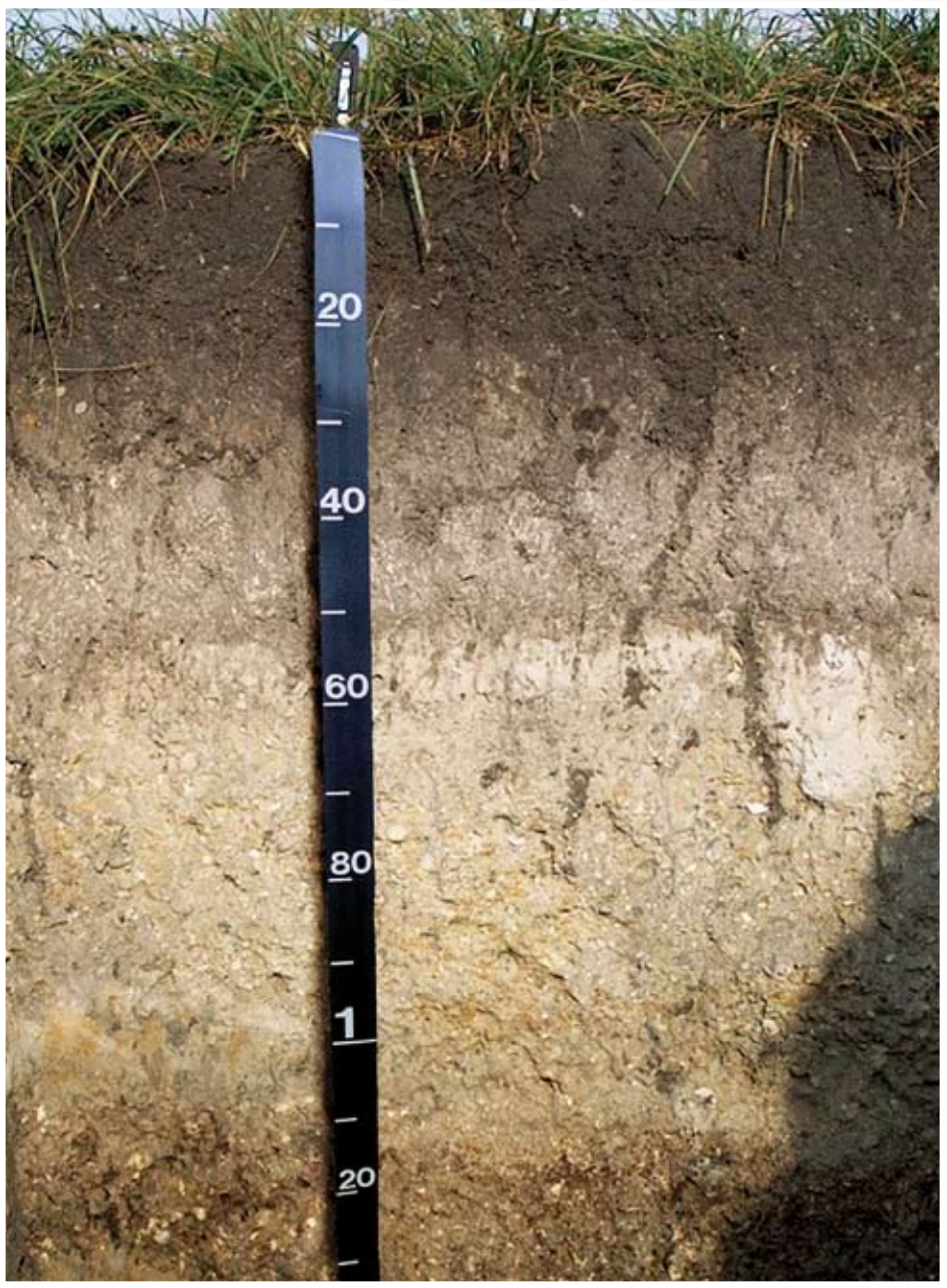
Fluvisols

(from the Latin, *fluvios*, meaning river)



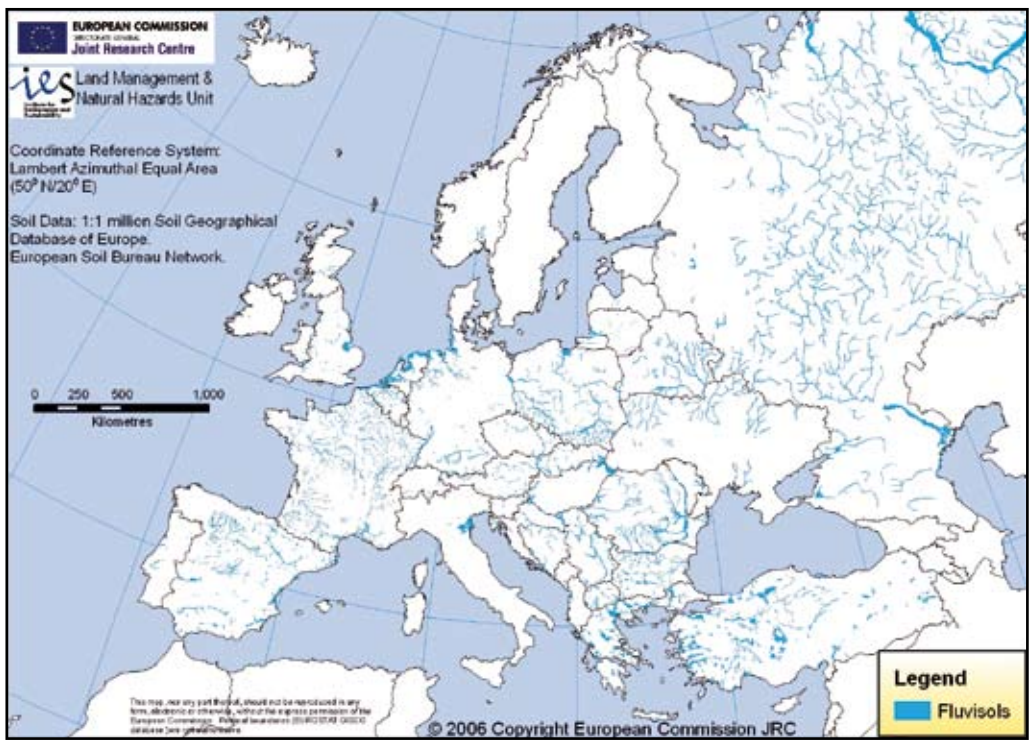
(EM)

Fluvisols are commonly found in periodically flooded areas such as alluvial plains, river fans, valleys and tidal marshes, on all continents and in all climatic zones. Fluvisols show a layering of sediments rather than pedogenic horizons (i.e. created by soil forming processes). Their characteristics and fertility depend on the nature and sequence of the sediments and length of periods of soil formation after or between flood events. Common international names are Alluvial soils, Fluvents (Soil Taxonomy) and Auenböden (Germany). This profile shows a Fluvisol from a tributary of the Danube.

April 2007

(EM)

Fluvisols develop due to the deposition of sediments in periodically flooded areas. This dramatic aerial photograph shows a river in flood that has broken its banks.



Fluvisols cover 5 % of the surface of Europe. The map clearly shows the distribution of large river floodplains of Europe.

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Cambisols

(from the Italian, *cambiare*, meaning to change)

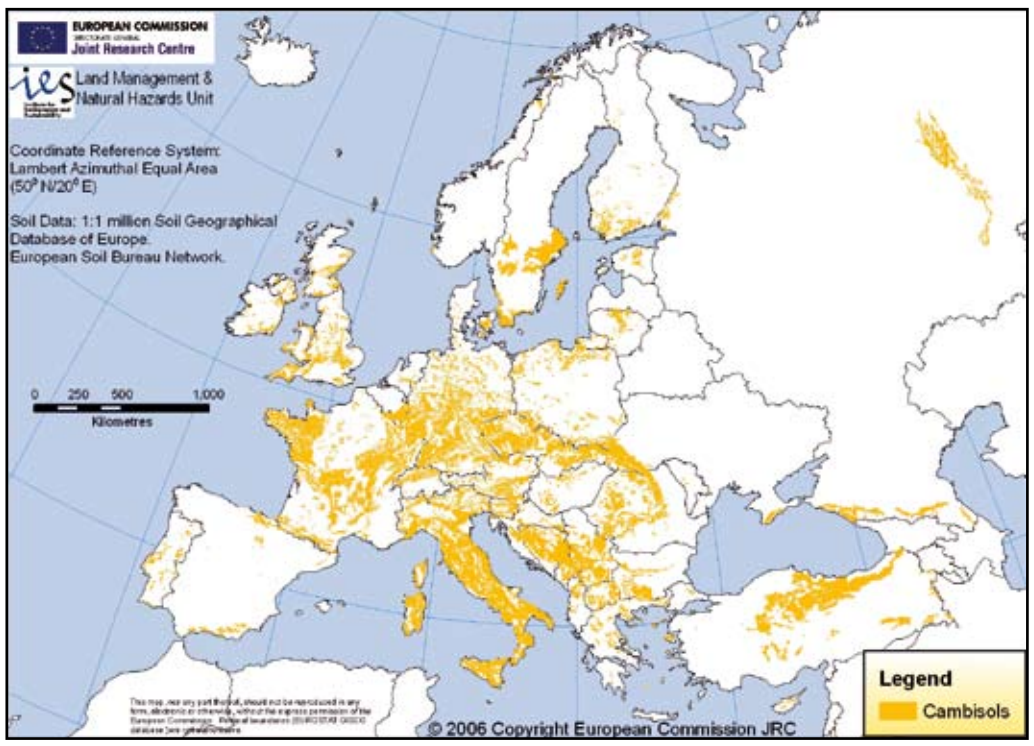
(EM)

A Cambisol is a young soil. Pedogenic (soil forming) processes are evident from variations in colour and/or the development of structure below the surface horizon. Cambisols occur in a wide variety of environments around the world and under many kinds of vegetation. Cambisols are commonly referred to as Brown Soils, Braunerde (Germany), Sols Bruns (France) or Brunizems (Russia). Soil Taxonomy classifies these soils as Inceptisols. This profile shows a Cambisol from the Carpathian Basin.

May 2007

(EM)

Cambisols are common in loess (a fine-grained deposit of wind-blown material) areas and can be very productive for agriculture. This recently harvested arable landscape is from France.



Cambisols cover 12 % of the surface of Europe and are typical of large parts of central and southern Europe.

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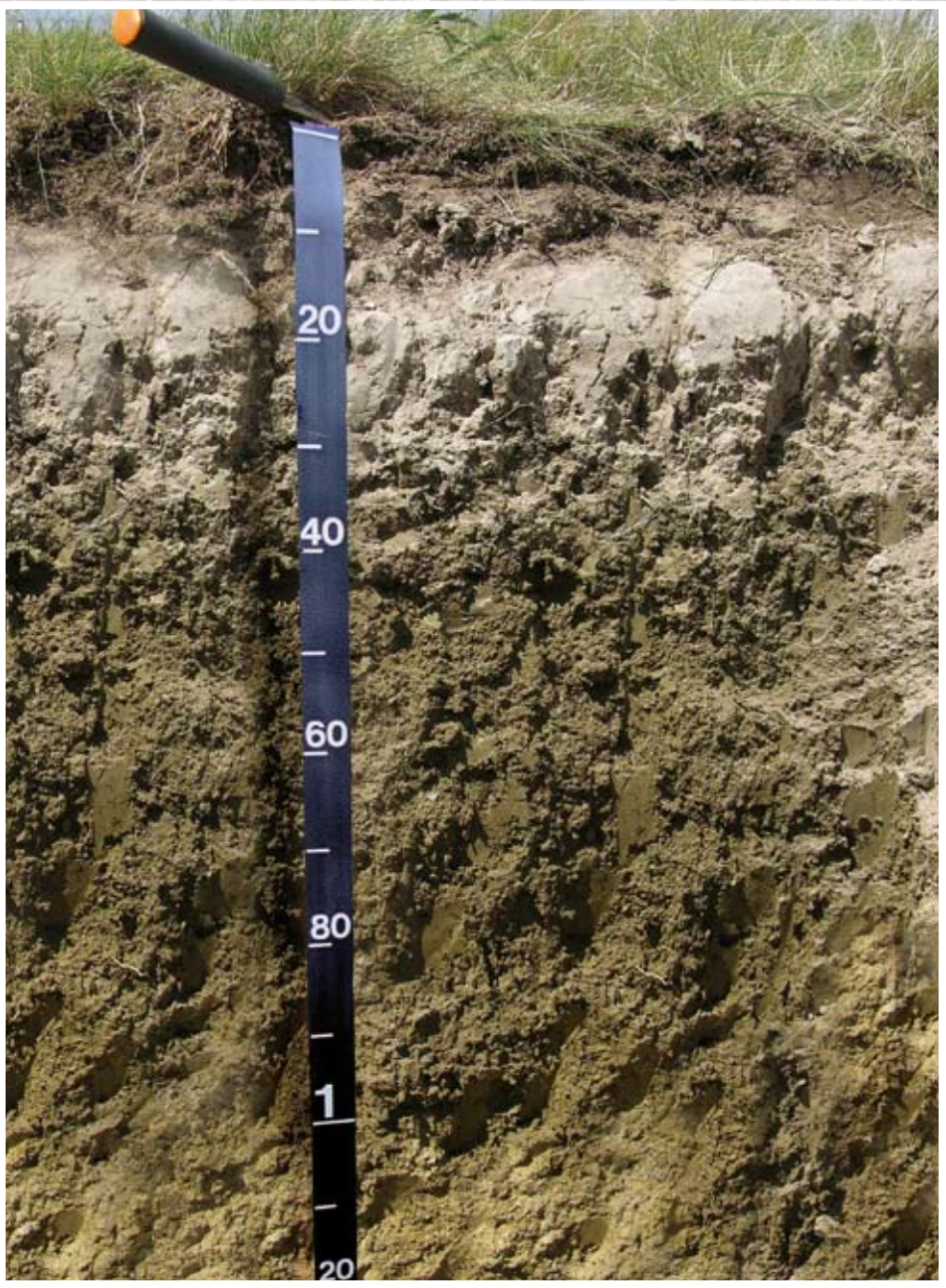
Solonetz

(from the Russian, *sol*, for salt, and *etz*, meaning strongly expressed)



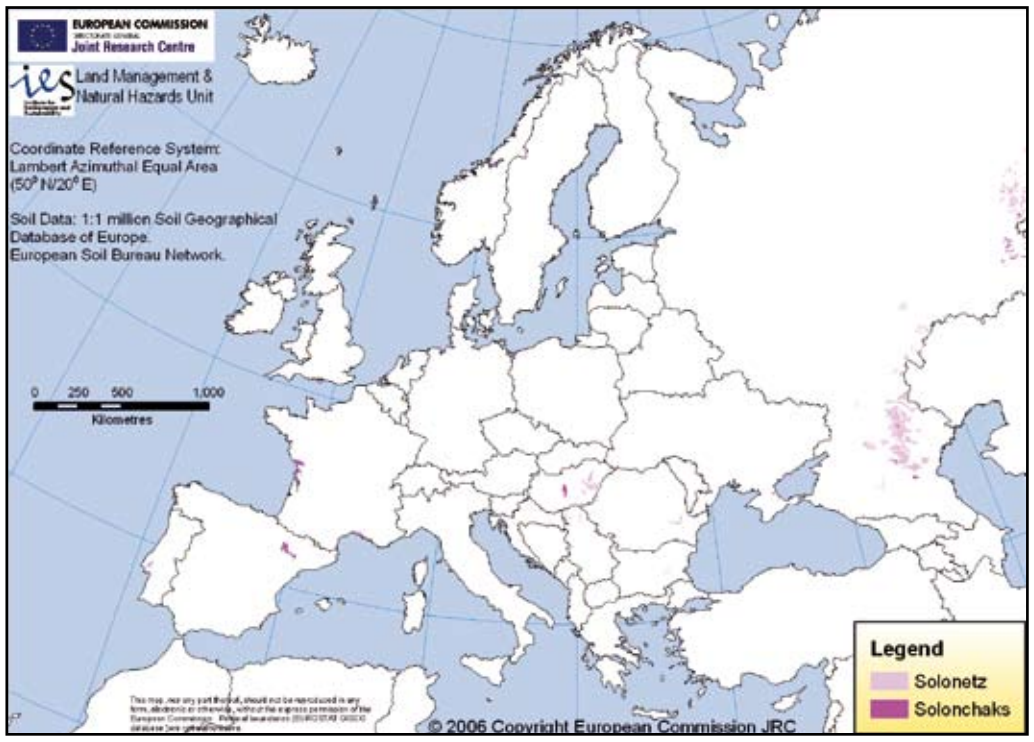
(EM)

A strongly alkaline (not acid) soil with a subsurface horizon of clay accumulation, strong columnar structure and a high proportion of adsorbed sodium and/or magnesium ions. Solonetz are normally associated with flat lands in a climate with hot, dry summers or with (former) coastal deposits that contain a high proportion of sodium ions. Solonetz occur mainly in Ukraine, Russia, Kazakhstan and Hungary. Internationally, Solonetz are referred to as “alkali soils” and “sodic soils”, “Sols sodiques à horizon B et Solonetz solodisés” (France), Natrustalfs, Natrustolls, Natrixeralfs, Natrargids or Natrargids (USA). The above example comes from Hungary.

June 2007

(EM)

This photograph shows typical salt tolerant vegetation and surface cracking that accompanies Solonetz. This example comes from Hungary.



Naturally saline soils cover <1 % of the surface of Europe. However, a build up of salinity in soil is an increasing problem in many irrigated areas in the Mediterranean area. Solonchaks are also naturally occurring saline soils formed when salt-rich ground-water comes close to the surface.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
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Chernozems

(from the Russian, *chern*, black, and *zemlja*, earth).

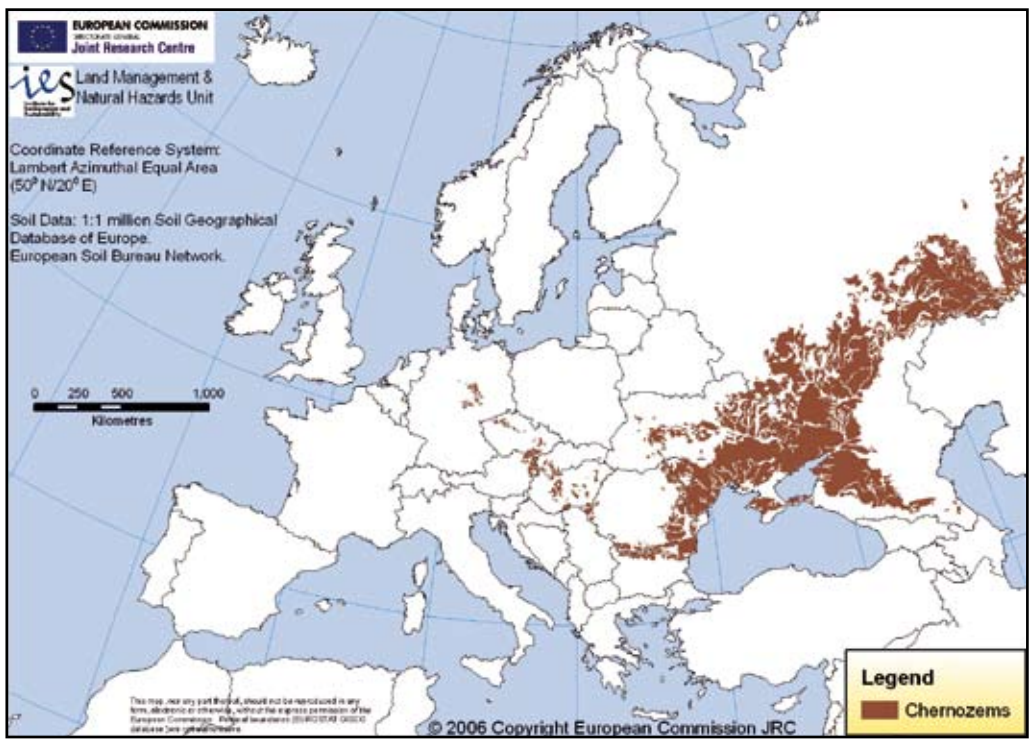
July 2007

(EM)

A soil type that has a very dark brown or blackish surface horizon containing a significant amount of organic matter, a high base saturation (i.e. alkaline characteristics) and a secondary accumulation of calcium carbonate within 50 cm of the lower limit of the humus rich horizon. Chernozems show high biological activity and are typically found in the long-grass steppe regions. Chernozems together with other typical steppe soils (e.g. Phaeozems, Kastanozems) are among the most productive agricultural soil types in the world. This profile comes from the Hungarian Great Plain.

(ED)

The main source of the high organic matter content of Chernozems is the annual decay of the vegetation. The dark surface soil material is generally mixed to significant depths by the high biological activity.



Chernozems cover 9 % of the surface of Europe and clearly show the former steppe region of Eastern Europe.

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Calcisols

(from the Latin, *calcarius*, meaning lime rich)

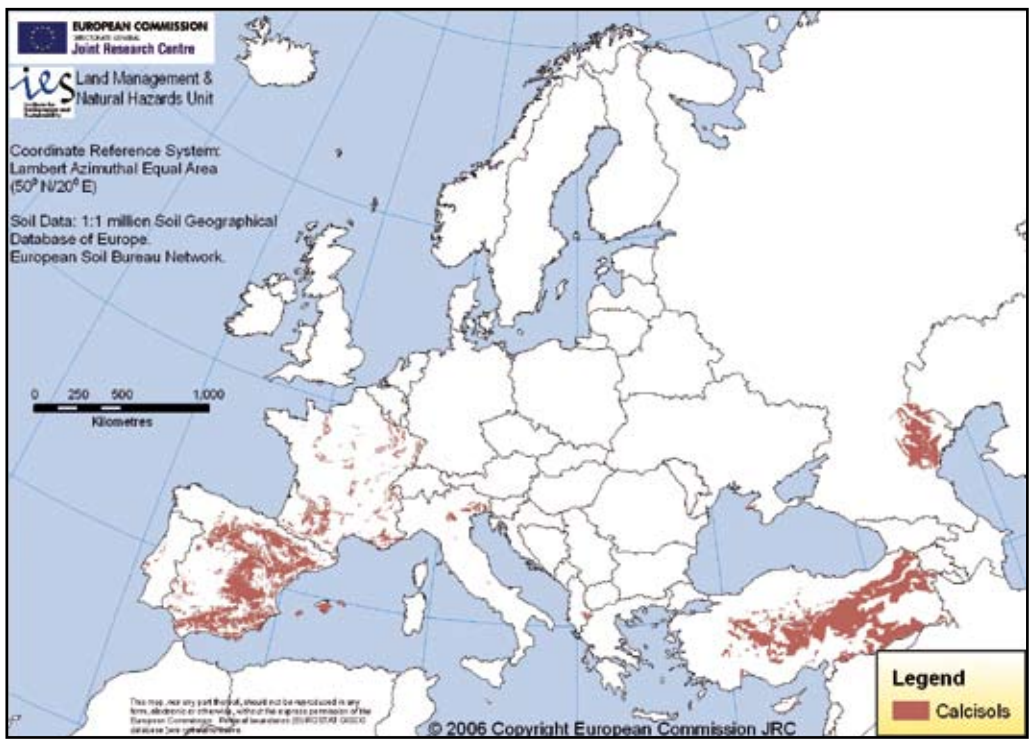
August 2007

(EM)

Calcisols possess a substantial movement (translocation) and accumulation of secondary calcium carbonate. The precipitation may occur in the form of “pseudomycelium” (root channels filled with fine calcite), nodules or even in continuous layers of soft or hard lime (calcrete). Calcisols are common on calcareous parent material (e.g. limestone) in regions with distinct dry seasons as well as in dry areas where groundwater rich in carbonate comes close the surface. Formerly, Calcisols were internationally known as “Desert soils” and “Takyrs”. This fine example comes from Spain.

(EM)

This photograph from Greece, clearly illustrates the typical Mediterranean landscapes of olive and fruit orchards that grow well in irrigated Calcisols.



Calcisols cover 5 % of the surface of Europe and are common in Southern Europe.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
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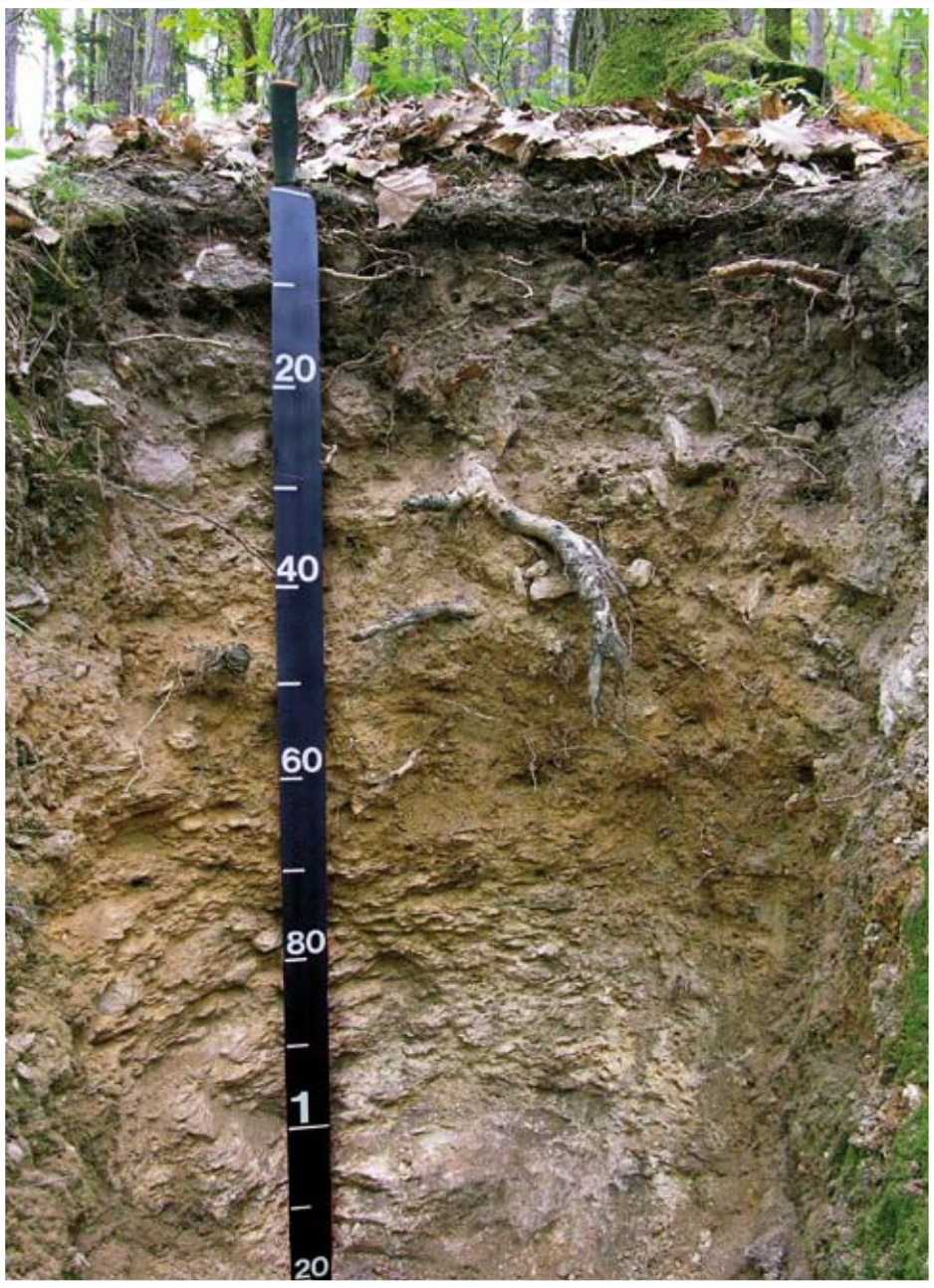
Luvisols

(from the Latin, *luere*, meaning to wash)



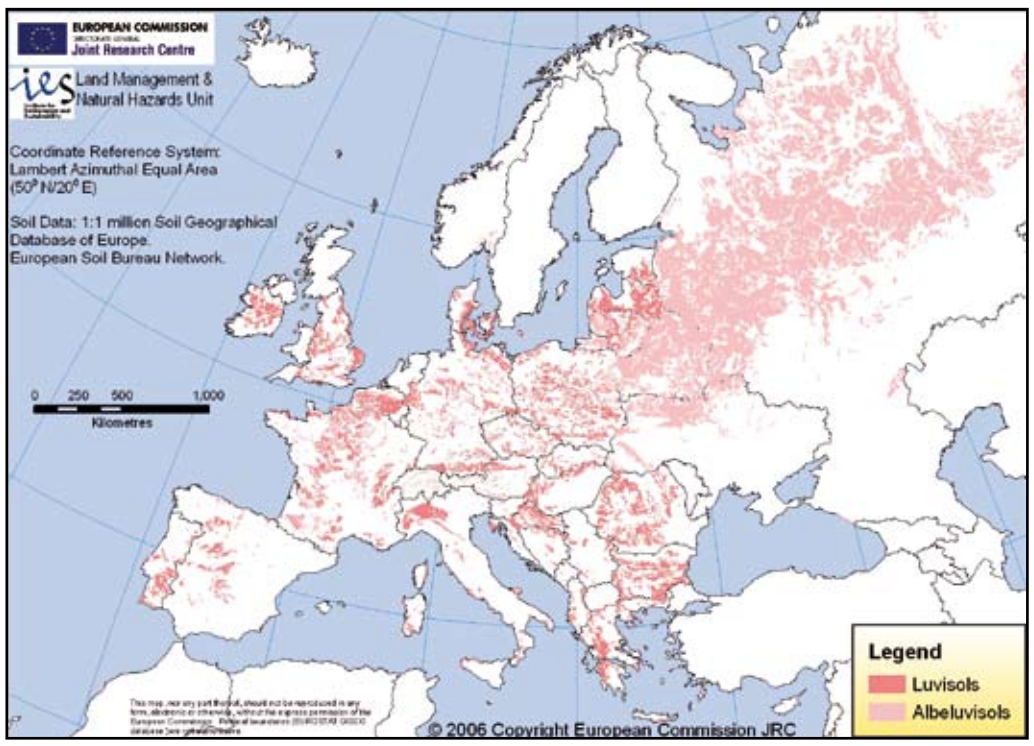
(IW)

Luvisols show marked textural differences within the profile. The surface horizon is depleted of clay while the subsurface "argic" (clay-rich) horizon has accumulated them. A wide range of parent materials and environmental conditions has led to a large diversity in this Reference Soil Group. Other names used for this soil type include Pseudo-podzolic soils (Russia), sols lessivés (France), Parabraunerde (Germany) and Alfisols (Soil Taxonomy). This profile comes from Germany.

September **2007**

(EM)

Luvisols generally develop under forest vegetation on well drained landscapes. This picture comes from Germany.



Luvisols are relatively common and are often associated with Albeluvisols (see front cover and back page). Together, these two soil types cover 21 % of the surface of Europe.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
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Umbrisols

(from Latin, *umbra*, meaning shade)

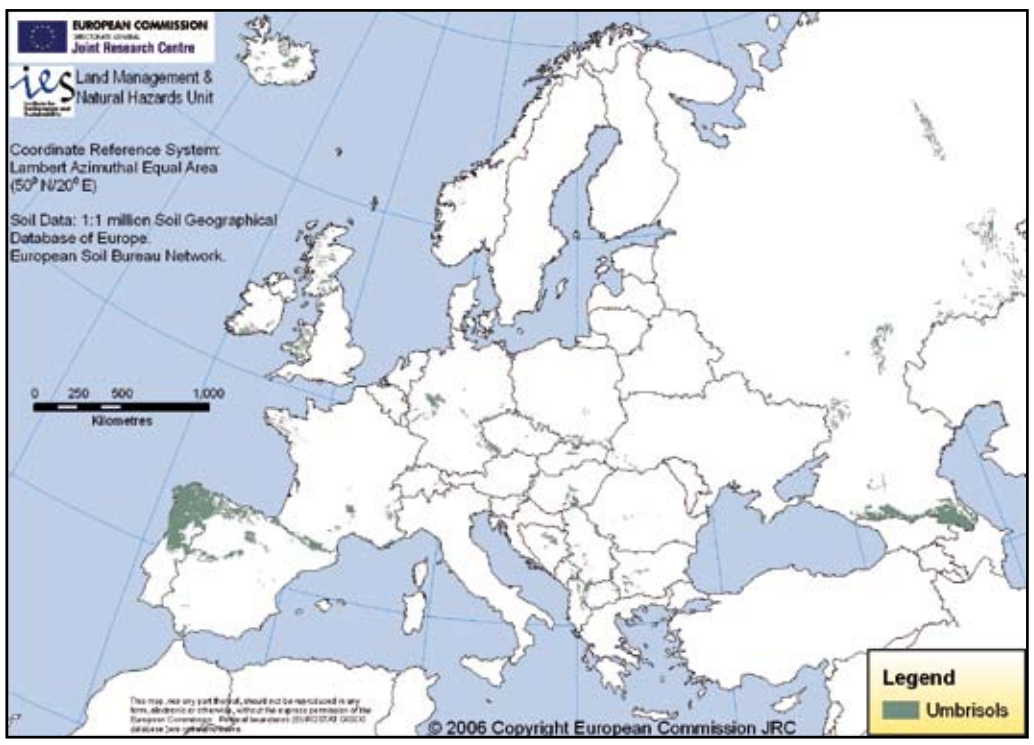
(EM)

Umbrisols generally develop in cool and humid climates where precipitation considerably exceeds evapo-transpiration. They are usually associated with acid parent materials. In other mapping systems, this soil type is classified as Umbrepts and Humitropepts (Soil Taxonomy), Humic Cambisols and Umbric Regosols (FAO), Sombric Brunisols and Humic Regosols (France). This profile comes from the north of Italy.

October **2007**

(EM)

The predominance of sloping land and wet or cool climatic conditions restricts the utilization of Umbrisols. This typical landscape comes from UK.



Umbriols cover 2.5 % of the surface of Europe and indicate areas of high precipitation and/or altitude.

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Podzols

(from the Russian, *pod*, for under, *zola*, meaning ash)

November **2007**

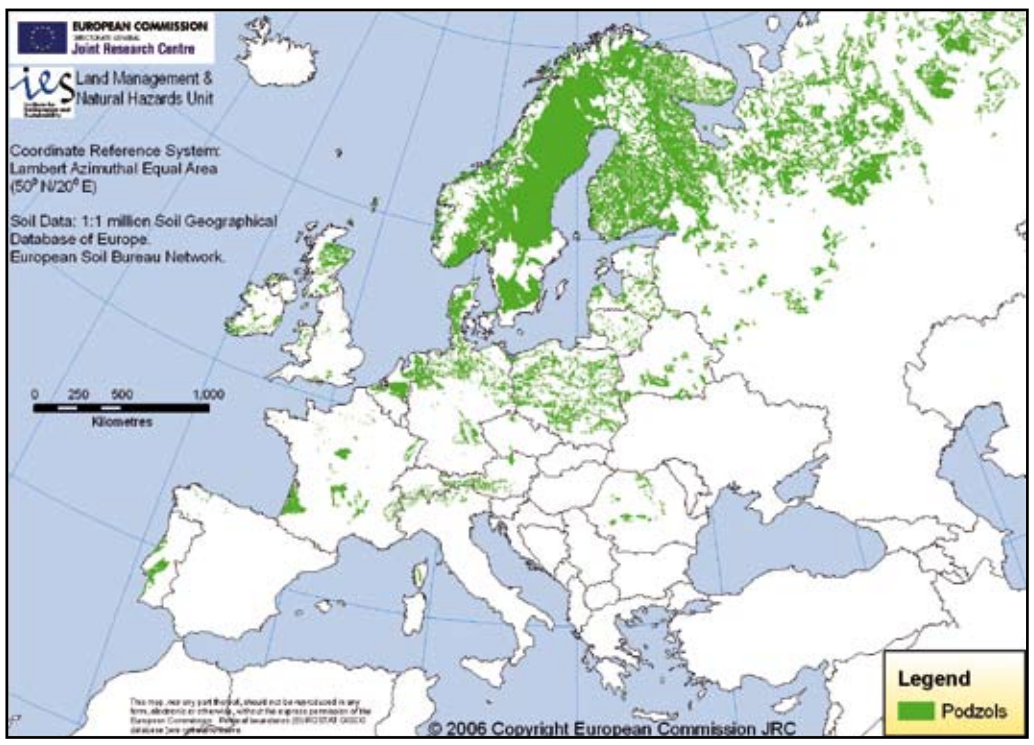
(EM)

Podzols generally have profiles of markedly contrasting horizons. Under acidic conditions, percolating rainwater migrates aluminium, iron and organic compounds from the surface layer to the deeper B-horizon. The humus (organic) material is re-deposited in an accumulation (spodic) horizon while the overlying soil is left behind as a strongly bleached “albic” (devoid of clay and iron) horizon.

The name “Podzol” is used in most national and international soil classification systems. This striking example comes from Czech Republic.

(EM)

Most Podzols in Europe develop in humid, well drained areas, particularly in the Boreal and Temperate Zones under vegetation with acidic litter. This forest is in Russia.



Podzols, one of the commonest soil types, cover around 14 % of the surface of Europe and are characteristic of northern or mountainous landscapes.

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Cryosols

(from the Greek, *kraios*, meaning cold or ice)

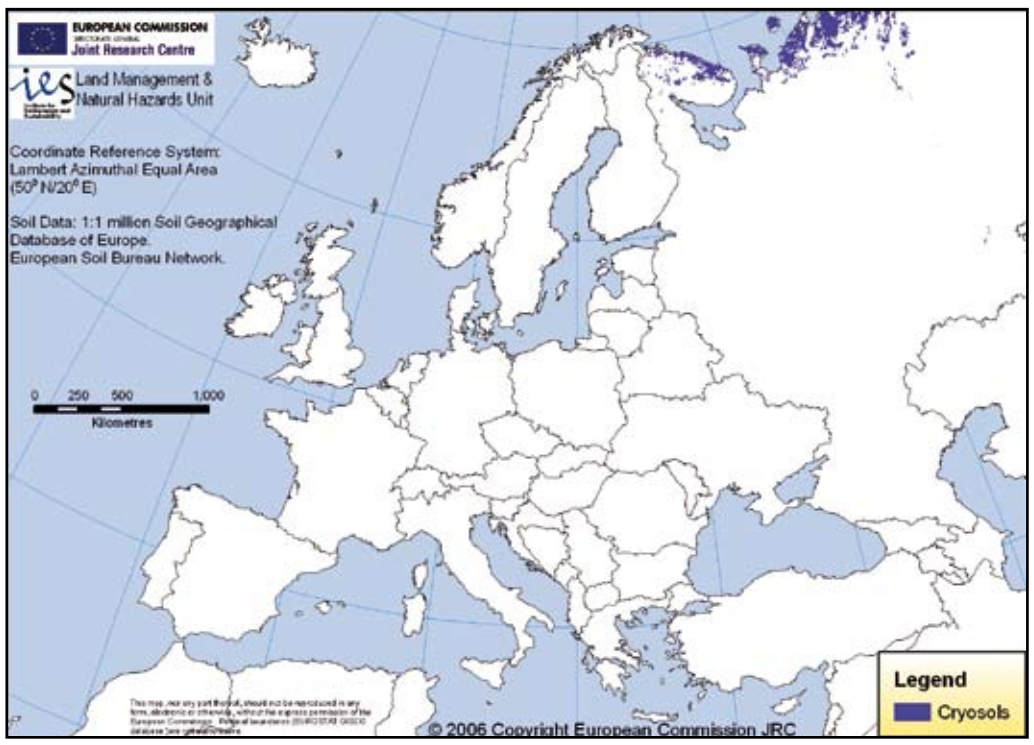
December **2007**

(GT)

Cryosols develop in arctic and mountainous regions where permanently frozen subsoil or “permafrost” is found. In this type of soil, water occurs primarily in the form of ice and cryogenic (associated with low temperatures) processes, such as freeze-thaw sequences, cryoturbation, frost heave, cryogenic sorting, thermal cracking and ice segregation, are the dominant soil forming processes. These processes result in distorted horizons and patterned ground. They are widely known as Permafrost soils, Gelisols, Cryozems, Cryomorphic soils and Polar Desert soils. This Russian profile clearly shows the distorted horizons and ice within the profile.

(CH)

Patterned ground is a common feature of Cryosols in the tundra regions. This distinctive patterned ground landscape is in Russia.



Cryosols cover 2 % of the surface of Europe and are confined to the Arctic Circle (67.50°N).

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
					1	2
3	4	5 World Soil Day	6	7	8	9
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The World Reference Base for Soil Resources (WRB)

The units on the map below and the description of soil types in the calendar are given according to the World Reference Base for Soil Resources (WRB), the official correlation soil classification system of the International Union of Soil Science (IUSS) and the accepted common scheme of soil data bases of the European Union. In addition to serving as a link between existing classification and soil information systems and soil inventories, the WRB also serves as a consistent communication language between soil scientists.

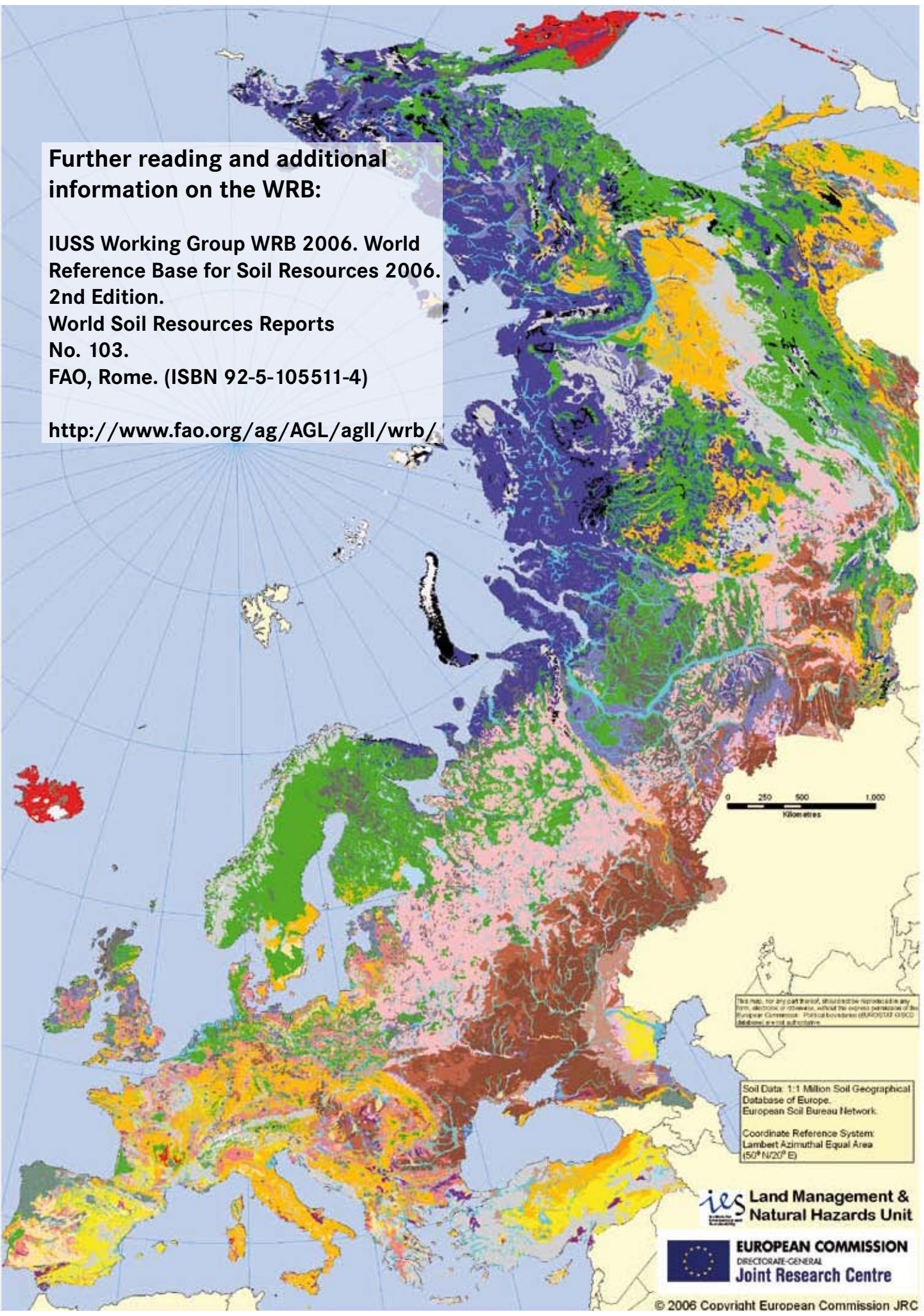
The classification of soil is based on the presence of diagnostic horizons, properties and materials, which to the greatest extent possible should be measurable and observable in the field. The WRB is a comprehensive classification system that accommodates national classification systems. WRB comprises two tiers of categorical detail (WRB, 2006)

- The first level of the WRB includes the Reference Soil Groups (RSGs) that are determined by a key. The 32 RSGs serve to delineate the broad soil regions of the world and also as a reference base of the world's soil resources for a wideraudience.
- The lower level of the WRB system consists of combinations of prefix and suffix qualifiers that are uniquely defined and added to the name of the RSGs, thus allowing a precise characterization and classification of individual soil types.

Further reading and additional information on the WRB:

**IUSS Working Group WRB 2006. World Reference Base for Soil Resources 2006. 2nd Edition.
World Soil Resources Reports
No. 103.
FAO, Rome. (ISBN 92-5-105511-4)**

http://www.fao.org/ag/AGL/agll/wrb/



Distribution of WRB Reference Soil Groups throughout Eurasia.

The distribution of the major soil groups as shown by the adjacent map is largely driven by the considerable range of bioclimatic zones that exist in Europe and, from west to east, the reduced influence of Atlantic Ocean.

The presence of vast flat areas (e.g. North European and Russian plains) together with a uniform cover of loose deposits support a latitudinal zonality for soil that ranges from the Cryosols in the tundra, Albeluvisols, Podzols and Histosols in boreal and temperate forests, Phaeozems, Chernozems and Kastanozems in the temperate steppe to Calcisols, Solnetz and Solonchaks in the semi-desert of the Mediterranean Basin.

Soil cover of Western Europe shows a similar zonality, which is smoothed by the diversity of parent materials and the influence of oceanic climate. Mountains complicate the soil mosaic manifesting a change of soil type due to altitude.

WRB Reference Soil Groups

- Albeluvisols
- Acrisols
- Andosols
- Arenosols
- Anthrosols
- Chernozems
- Calcisols
- Cambisols
- Cryosols
- Fluvisols
- Gleysols
- Gypsisols
- Histosols
- Kastanozems
- Leptosols
- Luvisols
- Phaeozems
- Planosols
- Podzols
- Regosols
- Solonchaks
- Solonetz
- Umbrisols
- Vertisols
- Urban
- Soil disturbed by Man
- Lake
- Marsh
- Glacier
- Rock Outcrop

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Robust science for policy making

The mission of the JRC is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

Europe faces public concern about complex issues such as food contamination, genetic modification, chemical hazards, global change, environment and health, and nuclear safety. The Joint Research Centre (JRC) supports EU policy makers in the conception, development, implementation and monitoring of policies to tackle such trans-national and global problems. More than 25% of EU legislation has a technical or scientific basis and this trend is likely to grow as increasingly policies cut across several disciplines. The JRC, as the Commission's in-house research based policy support centre, works to provide such support throughout the policy process, while maintaining a strong science base.

Our status as a Commission service, which guarantees our independence from private or national interests, is crucial for pursuing our mission. Our institutes carry out extensive research of direct concern to European citizens and industry. Over the years, the JRC has developed special skills and unique tools to provide autonomous and Europe-wide expertise to improve understanding of the links between technology, the economy and society. Our activities range from the assessment of safety standards for children's toys and improved biomaterials for hip implants to new technologies for recycling water and the use of satellite systems to monitor land use and deforestation. Our work is split between institutional research in support of Commission policymaking, direct support for specific Directorates-General (DGs) and competitive activities in strategic relationships with the scientific and business communities. Our guideline is that of 'adding value' where appropriate, rather than competing directly with establishments in the EU Member States.

The JRC consists of seven different institutes, each with its own focus of expertise, on five separate sites around Europe. The Institutional and Scientific relations provides coordination and serves as a link between the institutes and the policymakers.

http://www.jrc.ec.europa.eu/

The picture on the front cover of this calendar is an Albeluvisol from Latvia: a dark surface horizon is underlain by a thin layer of bleached material that is tonguing into the deeper clay-rich (brown) horizon in an irregular fashion. The light-coloured polygonal pattern at the base of the profile suggests the influence of permafrost in the material from which the soil developed (EM).

Located in Ispra (Italy), the Institute for Environment and Sustainability is one of the seven institutes that constitute the Joint Research Centre of the European Commission.

Institute for Environment and Sustainability

In line with the JRC mission, the aim of IES is to provide scientific and technical support to European Union strategies for the protection of the environment contributing to a sustainable development. IES works in close collaboration with official laboratories, research centres and industries of the EU's Member States, creating a bridge between the EU's policies and the European citizen.

The combination of complementary expertise in the fields of experimental sciences, modelling and remote sensing puts the IES in a strong position to contribute to the implementation of the European Research Area and to the achievement of a sustainable environment.

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The European Soil Bureau Network

Much of the material for this calendar has been collected through the JRC's European Soil Bureau Network (ESBN), an association of national soil science institutions and soil experts who support the Land Management and Natural Hazards Unit in collecting, harmonising, organising and distributing soil information for Europe that is relevant to support policies that have an impact on soil.

For more information on the JRC's soil activities please visit:
http://eusoils.jrc.ec.europa.eu/

The authors of this calendar, Arwyn Jones[1], Erika Micheli[2], Luca Montanarella[1], Marc Van Liedekerke[1] & Panos Panagos[1] gratefully acknowledge all contributions and the efforts of their colleagues and the ESBN partners to assemble the Soil Geographical Database of Europe and produce this document.

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