

NATURAL CONDITIONS AND RESOURCES OF DEVELOPMENT

Natural conditions across Ukraine show considerable variety. This is due to an intricate combination of geological structures from differing ages and the result of a diverse composition and related mineral resources. Additional variation across the country is represented in the distribution of mountains and plains, surface and sub-surface waters, air temperatures and moisture. Climatic conditions have favoured the formation of a wide range of soils and diverse wildlife – vegetation and fauna – all reflected by physico-geographical features and landscapes.

The **relief** of Ukraine consists mostly of plains, which make up 95% of its total area and belong to one of the largest of their kind – the East European Plain. To the south and southwest they are flanked by the mountains of the Crimea and the Carpathians. The average elevation of the plains is 175 m above sea level and reach a maximum height at Mount Berda (515 m), whereas the minimum levels are in the range of 0–15 m. There is a general orographical sloping from the north to the south and from the west to the east – the latter towards the Dnipro Valley, occupying a central position over the territory of Ukraine (*Figure 9*).

Another characteristic feature is a complex pattern of uplands and lowlands, the axes of which are orientated sublatitudinally, in a northwest–southeast direction. The plains include the following uplands: Podillian (with mean altitudes of 300–400 m and a maximum of 367 m); Donets (200–250 m, max. 367 m); Dnipro (150–240 m, max. 323 m); Volhynian (220–280 m, max. 342 m); and southwestern reaches of the Central Russian Upland (200–340 m). The following lowlands are also included: Black Sea Coastal lowland (0–170 m, max. 179 m), Dnipro (50–170 m, max. 236 m), and Polissian lowland (150–200 m, max. 316 m).

The mountains of Ukraine belong to the categories of low and middle mountains in elevation. The Ukrainian Carpathian foothills have altitudes from 300–400 m on the northeastern and southwestern macroslopes, up to summit levels of 1,500–2,000 m (with Mount Hoverla as the highest peak reaching 2,061 m). The Crimean

Mountains span average altitudes from 250 to 1,200 m with Mount Roman-Kosh as the highest (1,545 m). These mountain systems can further be subdivided into a series of orographic units of lower rank.

The present-day topography was sculpted in late Cainozoic times (including Quaternary) by a complex interaction of endogenous (internal) and exogenous (external) forces, and human-induced processes of relief formation. As a result of predominantly unidirectional and oscillating neotectonic crustal movements, volcanic and seismic processes have led to different proportions between accumulation and denudation. Plains evolved on the platforms and orogenic morphostructures formed.

The former are represented by socle plains, plains built, and hills formed upon horizontal strata (structural denudational, and denudational), and by aggraded plains of different genesis and age (mainly of glacial and fluvial origin). Mountain morphostructures belong to the collisional orogens type. They are represented by middle and low mountains of denudational tectonic, structural denudational and volcanic origin. Within piedmont troughs (Cis- and Transcarpathia and Indolo-Kuban) and in the adjoining mobile portions of platforms, morphostructures of transitional zones have been formed, to be found between mountains and plains predominantly with structural denudational and denudational relief.

Morphostructures on Ukraine's territory are manifest in the combination of relic and recent zonal, and azonal landforms of exogenic origin. Relic morphostructure is associated with the activity of early and middle Pleistocene inland glaciers having extended to the northern and central parts of the country's territory, and with that of mountain glaciation during the late Pleistocene. Recent morphostructures are represented by fluvial, gravitational, karstic, eolian, marine, lacustric and biogenic landforms. Present-day processes of relief formation – chiefly denudation – have a great part to play in soil degradation and they are frequent sources of other adverse processes.

Fig. 9

PHYSICAL MAP



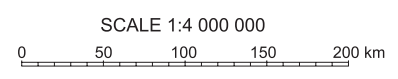
32° 33° 34° 35° 36° 37° 38°

Author: Kulyk, V.
Cartography: SSPE Kartografia
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Cartography: Kaiser, L., Keresztesi, Z., Kocsis, K., Kovács, A.
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32° 33° 34° 35° 36° 37°



Relief conditions have a strong impact on the spatial differentiation of soil and vegetation cover, and on climatic parameters within physico-geographical and higher level landscape taxa. Present-day natural processes of relief formation are instrumental in provoking mass movements (*Figure 10*).

The **geological structure** of the territory of Ukraine has resulted from a long and complex evolution, lasting for more than 3.8 billion years. In tectonic terms, the East European and (partly) West European platforms, Scythian plate and Paleozoic folded structures (Donets folded structure), Kimmerian-Alpine (Crimean Mountains) and Alpine (Ukrainian Carpathians) are of utmost importance. Basic regional platforms and orogenic geostructures have formed in different geodynamic stages: along island arcs and active continental margins, in internal parts of plates and aulacogens, in depressions situated in the interior parts of continents, collisional orogens, etc.

In the stratigraphical sequence of geological build-up, the rocks and sediments represented are those formed from the Archean up to the Quaternary. Of them, Archean and Proterozoic sedimentary-volcanogenic and volcanogenic deposits; metamorphic formations; and metasomatite rocks and granites are the most ancient and together they compose the crystalline fundament of the Ukrainian shield. The Phanerozoic sedimentary strata includes deposits of the Cambrian eratem, and those of Ordovician, Silurian, Devonian, Carboniferous, Permian, Triassic, Jurassic, Cretaceous, Paleogene, Neogene and Quaternary systems.

Ukraine is richly endowed with **mineral resources**, which can be attributed to geological formations of various ages and different tectonic structures in its territory. There are more than 20,000 proven occurrences of 97 different minerals in Ukraine. Due to their wide range and vast quantities, Ukraine is a country gifted with one of the widest selections of minerals worldwide.

For the national economy in general and industrial development in particular, the most important deposits are iron, manganese and uranium ore; coal, gas and condensate; oil fields; occurrences of titanium, zirconium, kaolin and graphite; non-ore raw materials for metallurgy; and decorative stones and minerals, along with thermal waters.

Deposits of **oil and gas** are concentrated in the Dnipro–Donets, Carpathian and Black

Sea–Crimea regions, situated in tectonic depressions of the East European Platform, Scythian Plate, piedmont troughs and continental shelves of the Black Sea and Sea of Azov (*Figure 11*). These regions include four provinces, and ten oil and gas-bearing areas. Over 300 sources of oil and gas are already explored in Ukraine and around 60 of them have significant proven reserves. Prospects of increasing quantities of recoverable hydrocarbon resources are promising, even if there is a sharp deficit of these types of energy source for the time being.

Estimated hydrocarbon resources exceed 8,400 million tons in oil equivalent, 27% of which are to be found predominantly at a depth of 5–7 km. By 2004, 26% of the initial resources had been extracted and 14.8% explored; the level of their realization was 45.8%. Solid fuels are found in the form of **hard and brown coal, oil and menilitic shales** and are to be found in the Donets, Lviv–Volyn, and Dnipro coal basins, and also in the Carpathians, Crimean Mountains and in Volyn–Podillia. An overwhelming part of hard coal reserves (*Figure 12*) are located in the Donets Basin (Donbas), where out of the 330 coal seams of Carboniferous origin, 180 are commercial. The total estimated resources of coal in Ukraine exceed 100 billion tons. Brown coal fields are primarily also found in the Dnipro Basin, interbedding in Paleogene deposits and situated at a depth between 10 and 150 metres below the surface, and in some places they are worked opencast.

Deposits of oil shale are encountered on the Ukrainian Shield, Volyn–Podillian Plate, in the Carpathian and Crimean Mountains, and the Bovtyshka Depression. Menilitic shales are frequent in the Ukrainian Carpathians.

With respect to **ferrous and ferrous-alloy ore**, Ukraine is the world's fifth largest producer of iron ore and the leader in manganese ore production, providing 4% of iron and 8% of manganese (*Figure 13*). There are 80 sites of iron ore occurrence with a general reserve of more than 30 billion tons. They are in the Kryvyi Rih Iron Ore Basin, in ore regions at Kremenchuk, Belozersk and along the coast of the Sea of Azov. Additionally there are deposits within the Ukrainian Shield and in the Kerch Iron Ore Basin in Crimea.

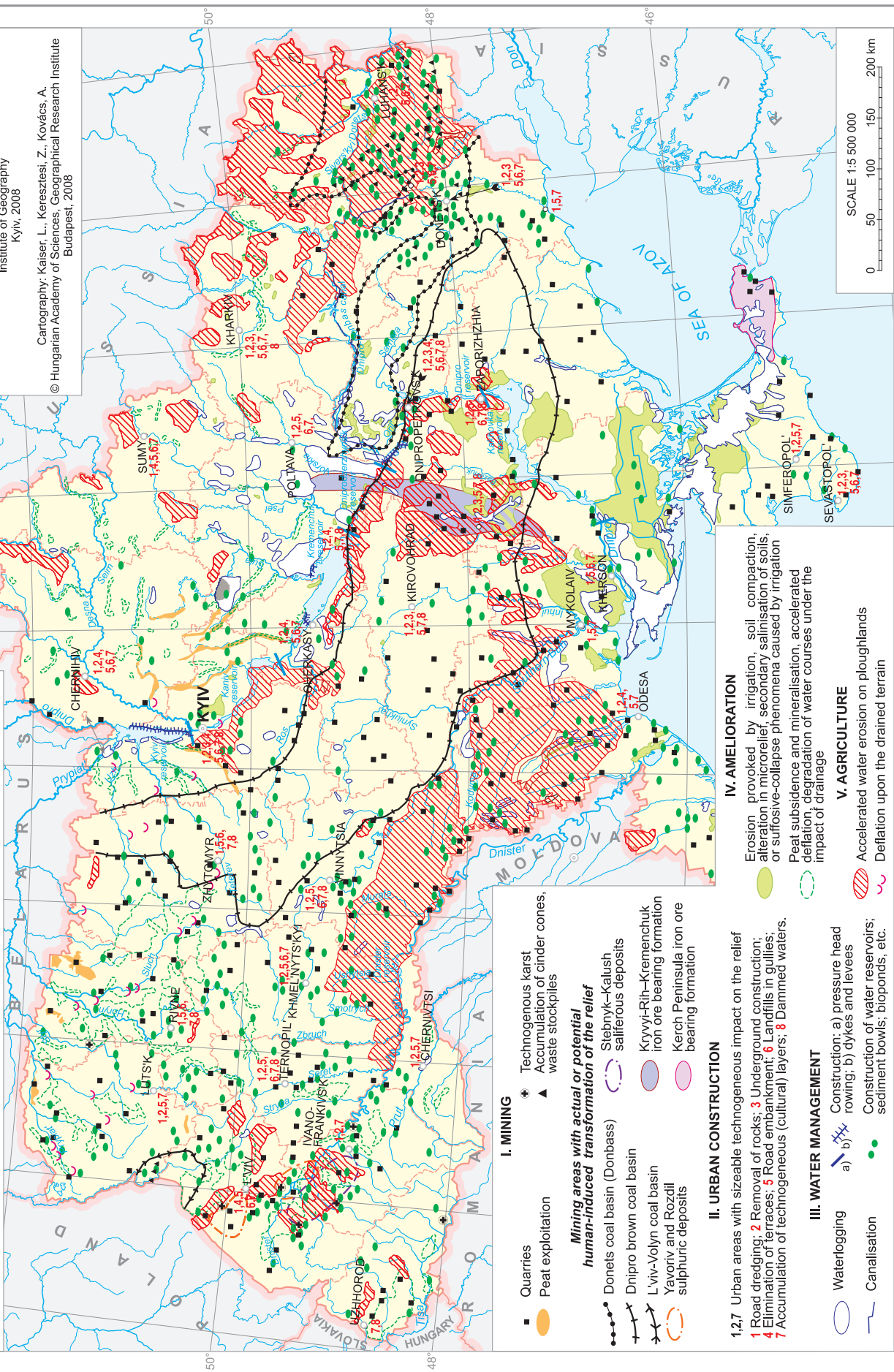
Manganese ores are centered on the Nikopol Ore Basin within the Ukrainian Shield. As far as general reserves are concerned, Ukraine

Fig. 10

HUMAN-INDUCED TRANSFORMATION OF THE RELIEF

Authors: Barschevskiy M., Zhytkin S., Palienko V.
 Cartography: Prokop'ieva, V. SSPE Kartohrafiia
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- I. MINING**
 - Quarries
 - Peat exploitation
 - Technogenous karst
 - Accumulation of cinder cones, waste stockpiles
- Mining areas with actual or potential human-induced transformation of the relief**
 - Donets coal basin (Donbass)
 - Dniipro brown coal basin
 - L'viv-Volyn coal basin
 - Yavoriv and Rozdil sulphuric deposits
 - Stebnyk-Kalush saliferous deposits
 - Kryvyi-Rih-Kremenchuk iron ore bearing formation
 - Kerch Peninsula iron ore bearing formation
- II. URBAN CONSTRUCTION**

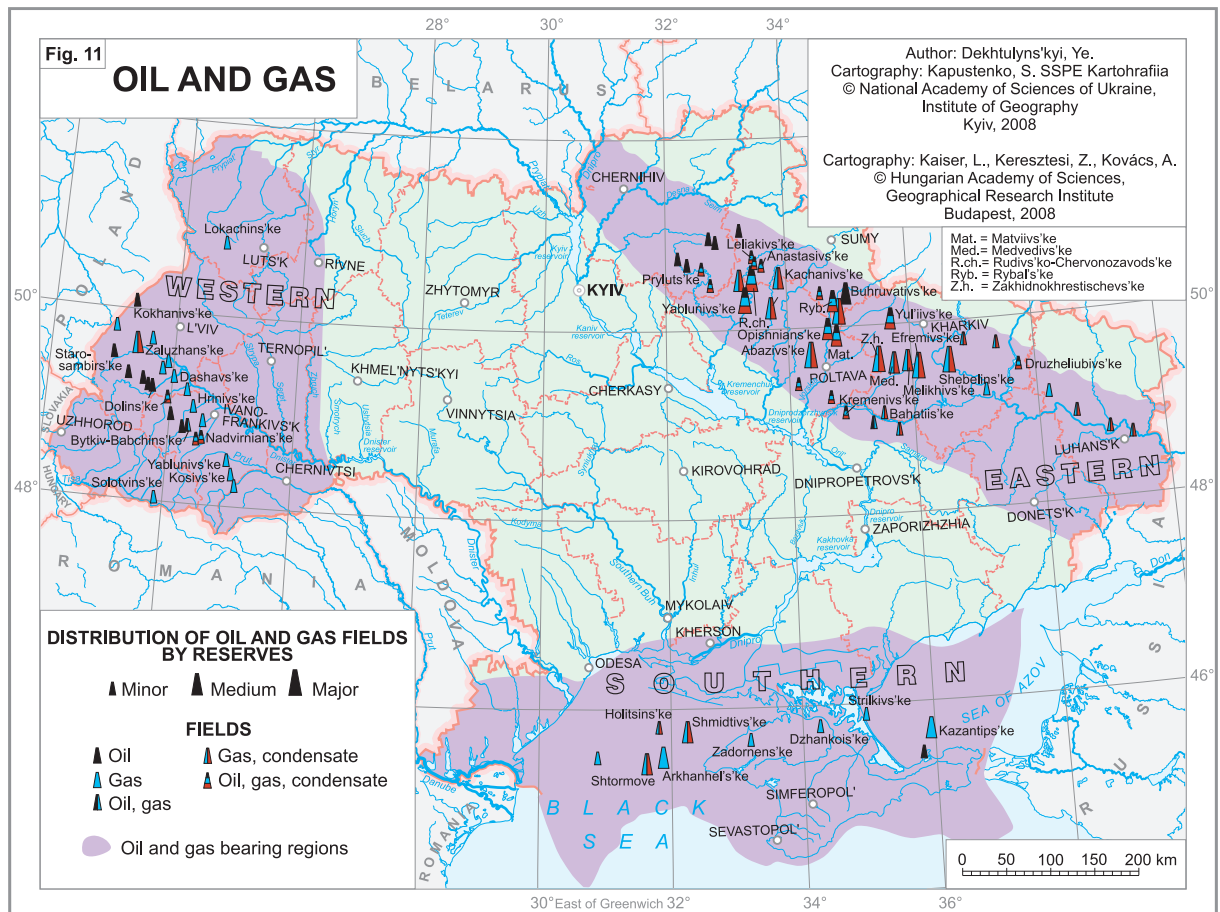
1,2,7 Urban areas with sizeable technogenous impact on the relief

1 Road dredging; 2 Removal of rocks; 3 Underground construction;
 4 Elimination of terraces; 5 Road embankment; 6 Landfills in gullies;
 7 Accumulation of technogenous (cultural) layers; 8 Dammed waters.
- III. WATER MANAGEMENT**
 - Waterlogging
 - Canalisation
 - Construction: a) pressure head rowing; b) dykes and levees
 - Construction of water reservoirs; sediment bowls; bioponds, etc.
- IV. AMELIORATION**

Erosion provoked by irrigation, soil compaction, alteration in microrelief, secondary salinisation of soils, or sulfurous-collapse phenomena caused by irrigation

Peat subsidence and mineralisation, accelerated deflation; degradation of water courses under the impact of drainage
- V. AGRICULTURE**
 - Accelerated water erosion on ploughlands
 - Deflation upon the drained terrain

34° East of Greenwich 36°



has 43% of the global total and with respect to explored reserves (2.5 billion tons) the country occupies second place globally. Chromite is also worked at the middle reaches of the Buh River (Ukrainian Shield). Ukraine is self-sufficient in raw materials for its iron and steel industries.

Gold has been mined in Ukraine for a long time, although gold-bearing capacities have not yet been sufficiently studied. For the time being there are 240 proven deposits and ore occurrences are found within three gold-bearing regions: on the Ukrainian Shield, in the Carpathians and the Donbas region. Prospecting has led to a conclusion about resources being associated with the activity of transregional sublatitudinal structures in central and north Ukraine, traversing diverse geostructures and also controlling the metallogenesis of non-ferrous and *rare metals*, e.g. that of silver and fluorite. Occurrences are concentrated on the Ukrainian Shield – a vast province of rare metals, such as beryllium, uranium, vanadium, scandium, niobium, zirconium, tin, molybdenum, tungsten, ilmenite, etc. Ukraine's potential reserves of rare earth elements are the largest in Europe.

Over 100 occurrences of *diamond* and related minerals have been found on the Ukrainian Shield, in the Donbas region and on the Volyn-Podillian plate. They are associated with north, central and south Ukrainian megazones of activation and with impact structures.

With regards to *non-metallic* minerals, sulphur and potassium salt is worked in Ciscarpathia, table salt in Crimea, rock salt in Donbas, and chalk for the making of soda in the Carpathians. There are occurrences of non-ore raw materials for iron and steel smelting (quartzites, fire-resistant clays, dolomites, flux limestones, foundry sands), for cement production (limestones, chalk, marble, clay, gaize) and for glass, porcelain and faience production (quartz sand, kaolin, feldspars). In recent years, prospective deposits of apatite and phosphorite were discovered for the manufacture of fertilisers.

There are more than 3,000 quarries for *construction materials* – brickearth, perlite, haydite clay, building sand etc, and over 200 for materials used for decorative purposes. Ukraine is extremely rich in various precious stones. On its territory, 155 occurrences are to be found with

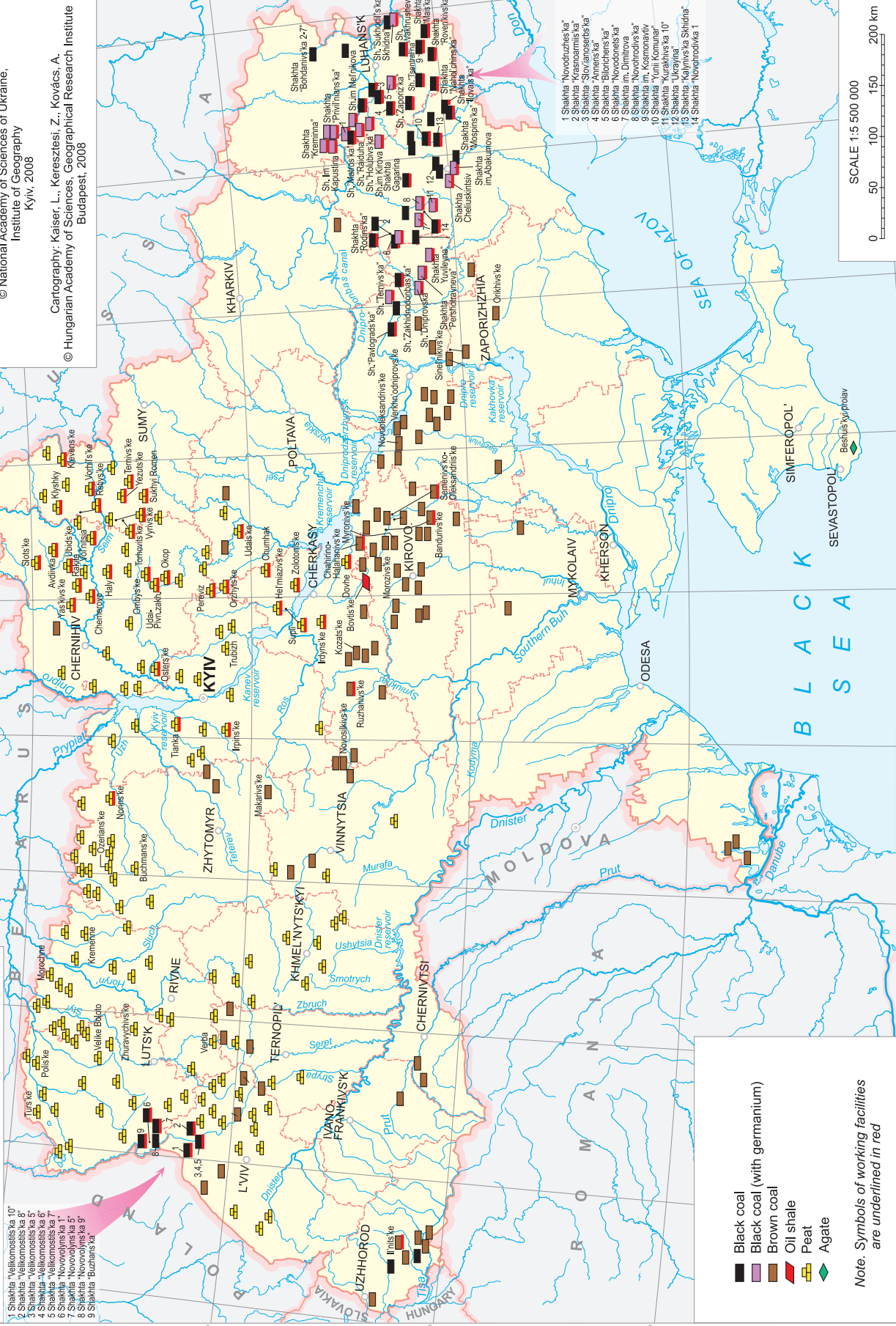
Fig. 12

SOLID MINERAL FUELS

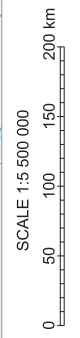
- 1 Shakhita "veikomostis" ka 10"
- 2 Shakhita "veikomostis" ka 8"
- 3 Shakhita "veikomostis" ka 5"
- 4 Shakhita "veikomostis" ka 3"
- 5 Shakhita "veikomostis" ka 2"
- 6 Shakhita "Novovolyns'ka 1"
- 7 Shakhita "Novovolyns'ka 5"
- 8 Shakhita "Novovolyns'ka 9"
- 9 Shakhita "Buzians'ka"

Authors: Radzivil, A., Pristinska, L., Dekhtulynskyi, Ye., Galatskyi, L.
 Cartography: Kapustenko, S.V. SSPE Kantofrafiia
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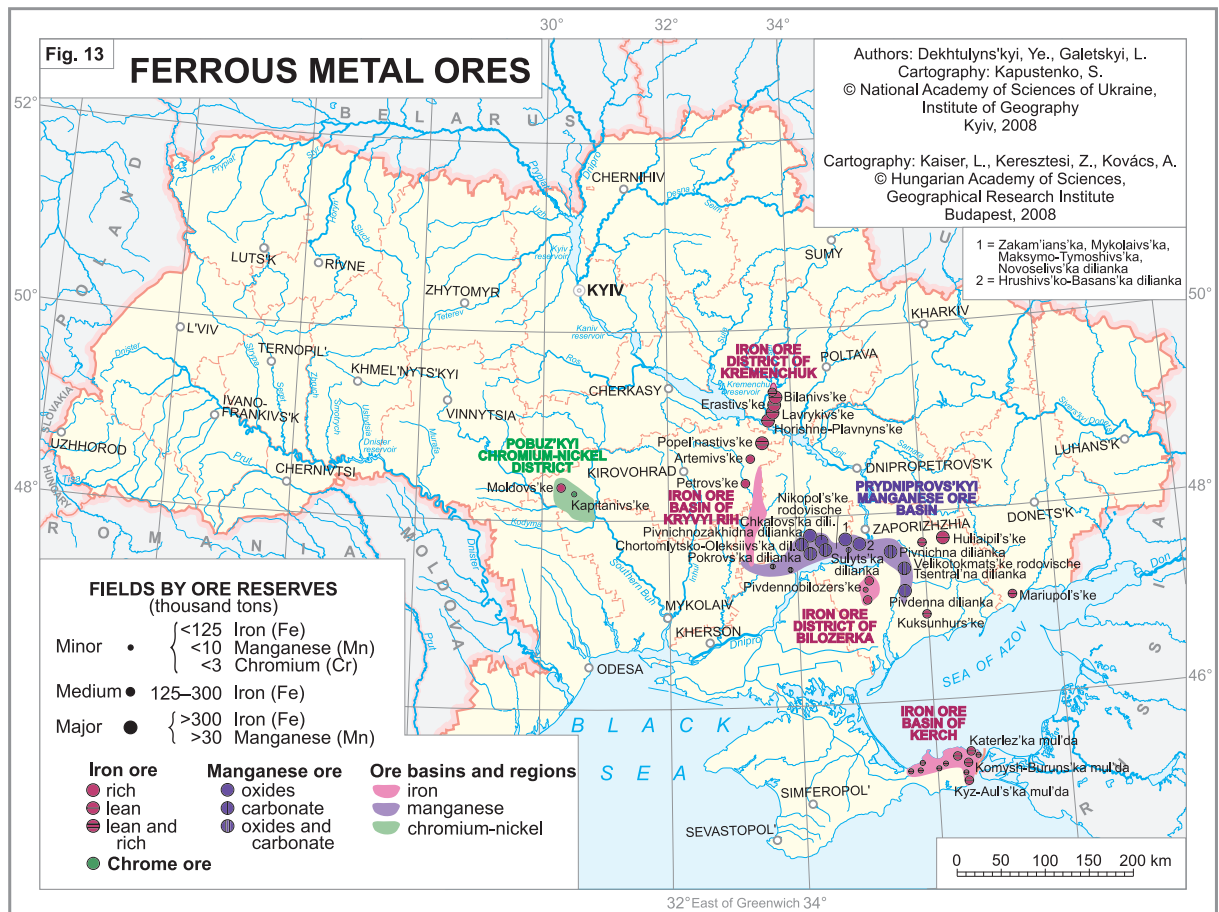


- Black coal (with germanium)
 - Black coal
 - Brown coal
 - Oil shale
 - Peat
 - Agate
- Note. Symbols of working facilities are underlined in red



28° 30° 32° 34° East of Greenwich

46° 48° 50°



proven reserves of 500 million m³ of stones, and 79 of them are worked. They are concentrated on the Ukrainian Shield, in Volyn, along the Dnipro River and the coast of the Sea of Azov. The stones quarried are topaz, beryl, morion, crystal, opal, garnet, and various decorative stones (granite, gabbro, marble, labradorite).

Geothermal resources of the country (in Ciscarpathia, Transcarpathia, on the plains of Crimea, the Kerch Peninsula and the Donbas region) are rich and the future prospects are good with a view to the long term. For the time being only 4% is used for energy generation. With respect to mineral water reserves, Ukraine is one of the world leaders. 110 sources of mineral water have been explored, and they demonstrate extremely diverse compositions. Carbonic, nitrate, methane, nitrate-methane, oxygen-nitrate, radonic and hydrosulphuric waters are encountered in several provinces. Azonal mineral waters with an organic hydrochemical composition of the “Naftusia” kind are widely known and have acquired popularity.

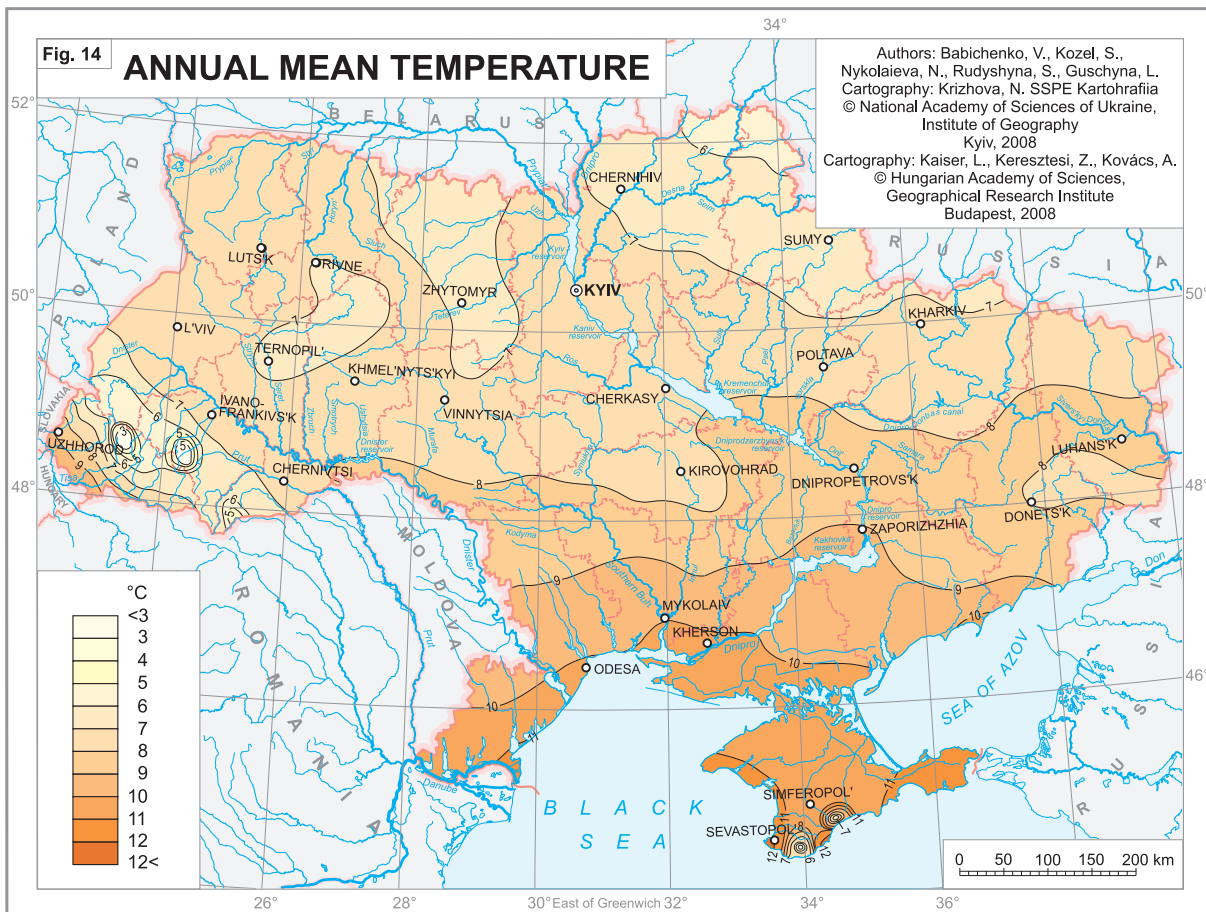
Recently, growing attention has been devoted to the recycling of industrial waste stored

at depositories, i.e. *technogeneous deposits*. Currently, Ukraine utilises a mere 12% of such waste matter.

Abundant and diverse mineral resources form the basis of, and provide raw materials for a variety of economic sectors: ferrous and non-ferrous metallurgy, oil refining, the engineering industry, the manufacture of chemicals and cement, etc.

Climate is one of the most important natural resources decisive in creating conditions suitable for human activities. Ukraine is overwhelmingly located within the temperate climatic zone, comprising forests and steppe, Atlantic and continental regions. Only the southern coast of Crimea enjoys true Mediterranean features, being situated in the subtropical zone (Figure 14).

The main characteristics of the climatic conditions and resources of Ukraine have formed under the influence of solar radiation factors, a regime of atmospheric circulation and features of the Earth's surface. Of them, the duration of *solar radiation* is the most important, which has a zonal-provincial character. Minimum dura-



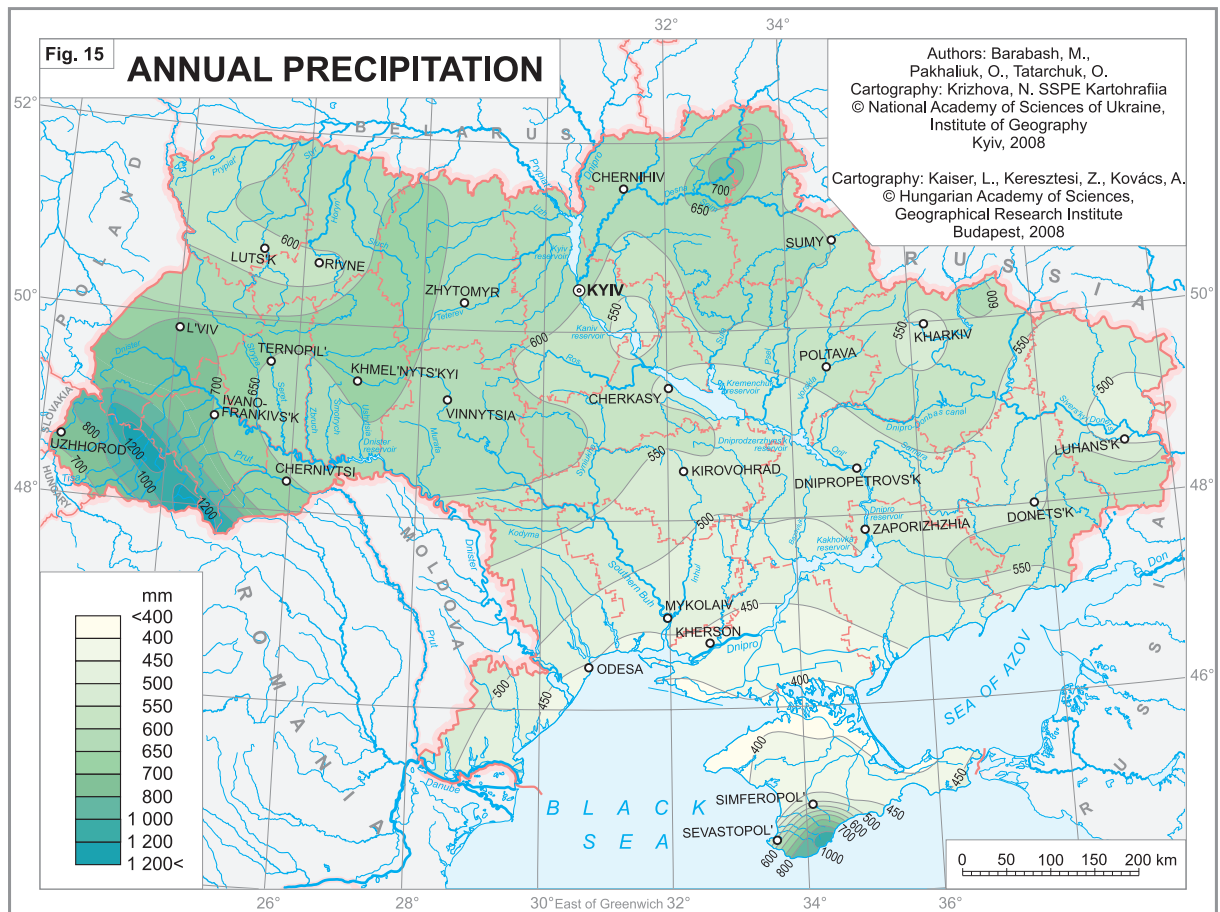
tion occurs in December in the zone of mixed (coniferous–deciduous) forests with 30 sunshine hours, up to 45 hours for the forest steppe zone and a maximum of 65 hours for the steppe zone. Maximum duration is typical for July: 240–300 hours in the mixed forest and forest steppe zones and 310–350 hours in the steppe. The minimum amount of sunshine hours during the year occurs in the western part of the mixed forests and forest steppe (1,700 to 1,800 hours), whereas the maximum occurs at Karaby Yaila (2,453 hours) and Simferopol' (2,458 hours). Seasonal distribution of direct solar radiation and its annual total have a strong influence upon the functioning of landscapes. Minimum values are recorded in December ($60\text{--}100\text{ MJ/m}^2$) and maximum values are typical in summer ($1,600\text{--}2,100\text{ MJ/m}^2$).

Atmospheric circulation is responsible for the distribution of temperature and moisture on the Earth's surface (Figure 15). In Ukraine, the typical pattern is the transport of air masses from the Atlantic via westerly winds, and the flow of Arctic and continental air masses from Eurasia. In the variation of climate, an important role is played by cyclones and more than

40 are recorded annually in Ukraine, with each season bringing five to seven anticyclones. In the summer and autumn, anticyclones arrive from the west (Maximum of Azores). In winter the influence of the Siberian anticyclone is manifested and there are frequent invasions of cold air masses of Arctic origin.

Topography has an impact on cloud cover and the distribution of solar radiation. During the winter, the level of solar radiation is the highest in the Ukrainian Carpathians and Crimean Mountains ($420\text{--}460\text{ MJ/m}^2$). Mountain ridges protect Transcarpathia and the southern coast of Crimea from the invasion of cold Arctic air masses. An impact of the seas upon climatic conditions is also felt. In winter, the sea promotes a rise in the air temperatures of coastal areas. Water reservoirs, lakes, and different kinds of land cover (woodland, grassland, cropland) are all decisive for the fluctuations in the radiation balance, and are instrumental in the distribution of climatic characteristics.

During the calendar year, climate influencing factors vary by season. The coldest is *winter*, when mean daily temperatures drop



below 0°C and remain negative. Winter begins in November and the phenomenon described above is moving from the northeast to the south and southwest. January is the coldest month with mean daily temperatures between -7 – -8°C in the northeast and 3°C along the southern coast of Crimea. The lowest values of absolute minima were recorded in January (-42°C) and February (-39°C). During the winter season weather conditions are controlled by air masses transported from the Arctic, Atlantic, Mediterranean, and from the Eurasian continent. Frequent periods of warming are associated with the inflow of mild Atlantic and Mediterranean air masses. They are typical of the southern and western regions. In winter, atmospheric phenomena such as fog, blizzards and ice can all appear; thunderstorms may occur along the cold fronts, in periods of warming.

Spring starts with the rise of mean daily temperatures above 0°C. In Ukraine spring arrives earliest in Crimea, in the southwest and Transcarpathia in middle to late February. In the northern areas this occurs in the middle of March. The duration of the spring season var-

ies between 50–55 days in the east and 70–85 days in the west of the country. The season lasts around 80 days in the foothills and slopes of the Ukrainian Carpathians and around 100 days high in the mountains. Increasing air temperatures are recorded following the snowmelt, i.e. in March, when they may rise up to 20°C on the plains of Ukraine and reach 30°C in Crimea. The spring season terminates in May with a rise in mean daily temperatures above 15°C on the plains, but it mountain areas this typically occurs as late as June and early July.

Summer approaches in mid-May in most of Ukraine; in the beginning of May in the south, and later in the west and north. The beginning of summer is marked by a rise in mean daily temperatures above 15°C and its imminent end is indicated by their decrease below this value in the first part of September. Solar radiation is a basic factor influencing climatic conditions, processes and resources during the summer period. The highest figures of radiation balance are recorded in June and overall, summer is moderately warm in Ukraine. Its duration is different in various regions of the country and lasts up to

100 days in the zone of mixed forests, 120–130 days in the steppe and 140–150 days along the coasts of the Black Sea and Sea of Azov. Mean temperatures are the highest in July, with absolute maxima of 38–40°C, gradually decreasing from the south to the north, and from the west to the east. The highest values are typical of the southern and south-eastern regions (39–41°C). The summer maxima of precipitation fall in June and July.

Autumn is imminent by mid-September and ceases by November with the drop in mean daily temperatures below zero. The season lasts 30–40 days, with a gradual reduction in the number of sunshine hours and an almost four-fold decrease of radiation balance, partnered with a simultaneous increase in the influence of atmospheric circulation upon the weather. Average temperature during the autumn season decreases rapidly by 4–8°C from September to November, whereas the amount of precipitation is 45–55 mm in the north and ca. 20 mm in the south. Days are shortening and the influx of cold Arctic air masses becomes increasingly frequent. In the majority of the country, autumn ends in the third decade of November, but on the sea-side of Crimea it terminates in late December.

Hazardous meteorological events are a frequent event in Ukraine and they can often have disastrous characteristics. In the cold period of the year, blizzards, frosts and fog are typical, whilst in the warm season extreme heat, dry winds, dust storms, heavy spells of rain, thunderstorms, squalls, spout and hail may occur. These phenomena are repeated year on year and affect areas of a variety of size.

For the time being, global processes have a real influence upon the climate of Ukraine. For example direct and total solar radiation have changed; air pressure has decreased in January and increased in July, winter temperatures have tended to increase and summer temperatures lowered. Further, the amount of precipitation has grown in the southeast and lessened in the northwest, extreme weather has become more frequent and there has been a general trend of the climate to turn milder.

Surface and subsurface waters. *Surface waters* include rivers, lakes, brackish lagoons (limans), water reservoirs, ponds, canals, swamps and marshes. There are 63,119 rivers and streams in Ukraine; of them 3,302 are longer than 10 km. The total length of watercourses

exceeds 206 km. The number of small streams amount to 63,029 (99.9%) with a total length of 185,771 km. There are 59,817 watercourses shorter than 10 km number and their combined length is 112,181 km.

The hydrographic network of Ukraine almost entirely drains into the Black Sea, with the exception of the catchment of the Vistula (Wisła) which belongs to the Baltic Sea basin. The largest drainage systems are those of the Dnipro, Dnister, Southern (Pivdennyi) Buh, Danube, and Northern (Sivers'kyi) Donets' rivers. Most of the watercourses eventually empty into the Dnipro (27.7%), Danube (26.3%) and Dnister (23.7%).

Catchment areas of the largest rivers are divided among several natural zones. By area, most of the watersheds remain less than 50 km² (95.9%). Average density of the drainage network (km/km²) on Ukraine's territory is 0.26 for the Dnipro, 0.60 for the Dnister, 0.35 for the Southern Buh, 0.22 for the Northern Donets' and 0.66 for the Danube.

Recharge of the watercourses is provided by snowmelt, rainfall and subsurface waters. For the rivers on the flatlands, snowmelt water is the basic source of replenishment (making up 50–80% of river flow). In the Carpathian and Crimean Mountains rainwater has a 20–25% contribution to river runoff. Recharge due to subsurface waters is typical of dissected uplands, where its share varies between 10–20%. The source of replenishment is decisive for the drainage regime of the rivers. Rivers on the plains are characterised by a high water stage and floods in spring; they experience a low water stage in summer; there is a slight rise in water level in autumn and a low stage during the winter. In the Ukrainian Carpathians floods may occur at any time of the year, whereas in Crimea they are typical of winter and spring-time.

Rivers in Ukraine transport a considerable amount of solid sediment. In the plains, the parameters of this bed-load depends on the natural zones they traverse: the annual average concentration of solid sediment varies between 20–50 g/m³ in the forest zone and between 100–250 g/m³ in forest steppe. In mountain areas, bed load may reach 1,000–4,000 g/m³ (Carpathians). Also, the hydrochemical composition of lowland rivers has marked characteristic features in differing zones. In the mixed forest zone, hydro-carbonate–calcium waters prevail, whereas

in the forest steppe zone, waters of the hydro-carbonate class mix with calcium-magnesium, calcium-sodium and sulphate; in the steppe zone waters of the hydro-carbonate-sulphate class dominate. Hydrochemical composition of mountain watercourses as a rule show a hydro-carbonate-calcium character. Average mineralisation of mountain rivers and streams varies between 160–350 mg/l within the zone of mixed forests, 320–570 mg/l for the forest steppe and 700–1,000 mg/l for the steppe zone. Human acts are a main contributor to this extensive mineralisation, contamination being responsible for 2 to 43% of mineral substances in the rivers of the Dnipro–Donets region.

One of the largest Ukrainian rivers is the Dnipro (Russian: Dnieper, ancient names are Borisfen, Slavutich). Its total length is 2,201 km; of this 1,121 km falls in Ukraine and the watershed occupies 504 thousand km². The Dnipro catchment basin extends to three countries – Russia, Belarus and Ukraine. Six water reservoirs were constructed on the river, which have profoundly modified the initial natural hydrological characteristics. The Dnipro springs from the Valdai upland in Russia, and flows across the zone of mixed forests, forest steppe and steppe. Its largest tributaries are the Prypiat', Teterev, Ros, Tiasmyn, Bazavluk, Desna, Trubizh, Sula, Psel, Vorskla, Oril' and Samara rivers.

The Dnister (Russian: Dniester, ancient name Tiras) rises in the Ukrainian Carpathians, near the village of Vovche in L'viv oblast, and empties into the Dnister Lyman along the Black Sea in Odesa oblast. Its total length is 1,362 km of which 925 km flows in Ukraine. The catchment area is 72.1 thousand km². Most of its tributaries are to be found in the middle reaches: Zolota Lypa, Strypa, Seret, Zbruch, Smotrych, Ushytsia, Murafa.

The Southern (Pivdennyi) Buh (Russian: Yuzhnyi Bug, ancient name Gipanis) takes its source near the village of Kholodets in Khmel'nits'kyi oblast and empties into the Dnipro–Buh Lyman on the Black Sea. Total length is 806 km, the catchment area occupying 63.7 thousand km². The largest tributaries are the Sob, Syniukha, Inhul, Zhar and Kodyma rivers.

In the east of Ukraine, the Northern (Sivers'kyi) Donets' (Russian: Severskyi Donets) is the largest watercourse; this right-hand tributary of the Don drains to the basin of the Sea of

Azov. Rising from the Central Russian Upland, with a total length of 1,053 km, it flows 700 km on the territory of Ukraine. The catchment area extends over 98.9 thousand km².

Eventually emptying into the Black Sea, only the lowermost reaches of the Danube (174 km) belong to the territory of Ukraine. The river is divided into three branches within its delta and the state border between Ukraine and Romania stretches along one of them (Kiliis'ke Dunai), at a length of 112 km. The rivers Tisa and Prut are the largest tributaries of the Danube.

There are around 200 thousand lakes in Ukraine; of them 43 have a surface-area of 10 km² or more. They are dispersed amongst various regions of the country and have differing genesis. The Shats'k lakes (or system of lakes) are in Volyn oblast, lying on the interfluvium between the Western (Zakhodnyi) Buh and Prypiat' rivers; most of them are within the Shats'k National Park. The largest of them is Lake Svitiaz', and has a surface-area of 27.5 km². Most of these lakes are karstic formations. However there are also lakes on Volyn Polissia formed by fluvial processes.

In the southern part of the country, brackish lagoons (lymans) are frequently encountered. They came about by marine transgression into the river mouths. Lakes in this category are located within the Danube delta (of them Yalpuh is the largest with 149 km² surface-area), in the mouth of the Dnister, Dnipro, Southern Buh, etc., such as Kuialnits'kyi, Khadzybeis'kyi, Molochnyi and other lymans.

A group of salt lakes of karst origin are located within Donets'k oblast, around Slovians'k. Salt lakes are also found in Crimea, in its Krasnoperekopsk raion (Perekopsk lakes) and around the town of Yevpatoriia, used for curative purposes and salt extraction. There are a cluster of salt lakes on the Kerch Peninsula (Kerch Lakes), near the coast of the Black Sea and Sea of Azov, and have a high concentration of mineral salt of up to 40‰. In some lakes mud has curative effect.

Of the mountain lakes, the dammed Lake Sinevir situated in the national park bearing the same name and Lake Brebeneskul' of glacial origin are notable (both in Transcarpathia).

In order to regulate river runoff, a system of artificial water bodies was constructed in Ukraine. There are 1,157 water reservoirs and 28,800 ponds and pools of non-uniform

distribution across the country. The largest reservoirs comprise the cascade on the Dnipro (Kyivs'ke, Kanivs'ke, Kremenchuks'ke, Dniprodzerzhins'ke, Dniprovs'ke, Kakhovs'ke) and one has been established on the Dnister (Dnistrovs'ke). Hydroelectric power plants operate on each of these reservoirs.

In the drainage basins of the Dnipro, Northern (Sivers'kyi) Donets' and Danube, canals were cut for water supply, irrigation, drainage and amelioration of cultivated land. The most important are as follows: North Crimean (Pivnichnokryms'kyi) Canal, Dnipro-Donbas Canal, Sivers'kyi Donets'-Donbas Canal, Kakhovs'kyi Canal, Dnipro-Kyvyi Rih Canal, and the Dnipro-Inhulets Canal.

Subsurface waters of Ukraine are freshwater resources widely used for consumption and an abundant supply of mineral waters (Figure 16). Freshwater resources are divided between several hydrogeological regions. Within the Ukrainian Shield they are to be found in the system of fissures in crystalline rocks and weathering products, and also in sedimentary rocks having formed in the Mesozoic and Cainozoic

periods. These water resources are scanty and of non-uniform extension. The largest reservoir of subsurface freshwater reserves is the Dnipro artesian basin comprising systems of aquifers embedded in Paleozoic, Mesozoic and Cainozoic formations. This basin has an extremely deep (between 300–800 m) zone of freshwaters. The Volyn-Podillian artesian basin includes a system of aquifers associated with Proterozoic, Paleozoic, Mesozoic, and Cainozoic deposits. The depth of these freshwater zones varies between 5–100 m. The artesian basin along the Black Sea includes freshwater stored in Cretaceous, Paleogene, Neogene and Quaternary deposits. These sources are characterised by a variability in the degree of mineralisation, and a presence of brackish and salt waters. The Donets artesian basin features aquifers in Carboniferous, Permian, Jurassic, Cretaceous and Quaternary rocks and sediments. Freshwater and water with a low salinity can be traced down to a depth of 500 m below the surface. The Ciscarpathian artesian basin is fed from the Quaternary horizon only. Other subsurface aquifers of the region are mineralised to a very large extent. Subsurface



waters in Crimea are associated with Taurian formation, Cretaceous and Paleogene, although aquifers have a low yield.

Mineral waters in Ukraine are highly varied with respect to their composition. Most important are those with hydro-carbonate, radium, sulphide (enriched with organic substance), boron, siliceous, arsenic, bromine, iodine, poly-metallic, and an iron content. They are stored in aquifers of different depth in diverse geological formations, and have a broad range of balneological utilisation.

The Black Sea and Sea of Azov are actually inland seas, belonging to the system of the Atlantic Ocean, and lap at the coasts of Ukraine, Russia, Georgia, Turkey, Bulgaria and Romania. The Black Sea is connected to the Mediterranean Sea through the Bosphorus, Sea of Marmara and Dardanelles, and linked to the Sea of Azov by the Kerch Strait. West to east, the width of *Black Sea* is 1,167 km, and its north to south span equals 624 km. It has a surface-area of 422,000 km². Depth is 1,300 m on average, reaching a 2,250 m maximum. The continental shelf occupies ca. 25% of the seafloor and is 200–250 km wide at the coast of Ukraine. Crimea is the biggest peninsula, whilst the largest bays are Karkinit's'ka, Kalamit's'ka, Feodosiis'ka, Yavorlits'ka, Dzharylhats'ka.

The surface water has an average salinity of 18‰, which is slightly higher than that of half the world's oceans. It contains oxygen and a thick layer of hydrogen sulphide. The water balance of the Black Sea is maintained by freshwater transported by the entering Danube, Dniipro and Rioni rivers and by the bottom currents enabling an inflow of seawater through the Bosphorus. The temperature of the upper layers can reach 23–26°C in summer, and drops to 6–9°C in the winter; it stabilises at a depth of 150 m at 9°C. Ukraine's most important harbours are located on the Black Sea coast: Odesa, Illichiv's'k, Pivdennyi (Yuzhne), Mykolaiv, Sevastopol', Yalta and Feodosiia. Nature reserves are also located here: Black Sea Biosphere Reserve, Danube, Karadag and Mis Mart'ian.

The *Sea of Azov's* coastline stretches some 2,686 km, half of which belongs to Ukraine and the rest a part of Russia. Arabatska Strilka (isthmus) divides the Bay of Syvash from the Sea of Azov. The watercourses of the Lozuvatka, Obytichna, Berda and Kal'mius empty into the sea arriving from Ukraine, whereas the Don,

Yeia, Chelbas, Beisug and Kuban' flow from Russia. The temperature of the upper layers reaches 24–25°C in summer and it cools down to -1°C during the winter when its northern parts are covered with ice. The Sea of Azov is an important waterway, with major seaports of Mariupol' and Berdians'k (Ukraine); Rostov-na-Donu and Taganrog (Russia).

Around 30% of offshore hydrocarbon reserves are located in the Ukrainian sector of the Black Sea and Sea of Azov. These deposits of natural gas and condensate of the continental shelf have been exploited at eight fields in the Black Sea and at six in the Sea of Azov.

Commercial fishing is an important sector of the national economy and the catch includes some highly valuable species. Various natural recreational resources are concentrated in the coastal strip of the Black Sea and Sea of Azov.

Water resources of the country include surface, subsurface and marine waters. Potential water resources are estimated at 209.8 km³. Only one quarter of this quantity is derived on Ukraine's territory. The country as a whole has a poor water supply, with respect to the combined river and local runoff. Surface flow of the largest rivers is 95.2 km³ and based on an annual average, amounts to a mere 1,000 m³/yr per capita. Water balance for subsurface water resources are estimated at 21.0 km³/yr and the total underground runoff amounts to 500–550 m³/sec. The volume of subsurface waters figuring in the water management budget statistics of the country, is 7.0 km³. 1.0 km³ of sea water is also used for various purposes.

Soils. Soil cover in Ukraine is a complex formation, being a function of the soil-forming parent rock, relief, climate and hydrological-morphological conditions (*Figure 17*). There is a pronounced latitudinal zonality over the plains with changing soil properties from the north-northwest towards the south-southeast, whereas vertical zonality is typical in the mountains. In the plains, there are sod-podsolic and grey forest soils; chernozems; chestnut; meadow soils; meadow chernozems and bog soils; solonchaks, solonetztes and solods. 65% of the soil in cultivated lands are chernozems, whilst grey forest soils make up 17%, sod-podsolic soils 7%, chestnut soils 4%, and other soils 8%.

Chernozems in Ukraine are represented by variations: podsolised, typical and ordinary chernozems. They have predominantly formed

on loess and loess-like deposits and are encountered mainly in forest steppe and steppe zones. The depth of the humified layer is 70–120cm, humus content in the upper horizon fluctuates between 3.5 and 6.5%. Hydrophysical characteristics are favourable for the cultivation of the land. In the subzone of dry steppes, i.e. in the northern part of the region along the Black Sea coast and in the southern areas of the Crimean plain, the so-called southern chernozems are encountered. Their humified layer is 50–55cm thick with 3–4% humus content in the uppermost horizon. Solonetz chernozems often form on saline clays; they have lower humus content and less favourable hydrophysical and physico-chemical properties. Chernozems in Ukraine are suitable for the cultivation of a great majority of agricultural plants.

Sod-podsolic soils are typical of sandr, moraine-sandr and alluvial plains, and in some parts of the forested terraces in the forest steppe and steppe zones. The depth of humified eluvial horizon is 18–22cm with 0.7–2.0% humus content. These soils can be subdivided into weak, medium and heavily podsolised, and can be categorised by water regime into automorphous, surface-gleyed and deeply-gleyed varieties. They produce an acid reaction of soil solution and are slightly saturated with basics. Sod-weakly podsolised sand and loamy sand soils are frequently encountered in Polissia, and sandy variations are associated with the eolian kuchugur uplands. They have a thin humified horizon, a low humus content (0.6–0.9%), a low capacity to absorb and store moisture and they are poor in nutrients. Nevertheless, using suitable farming technology they give fairly good yields of winter rye and potatoes.

In the uplands of Ciscarpathia, with its abundant atmospheric precipitation (above 700 mm annually) and medium and heavily podsolised gleyed sod soils, there is a need for regulation of the water regime, liming, and an application of fertilisers.

Second to chernozems, the most frequently encountered soils in the forest steppe zone are *light-grey, grey and dark-grey podsolised soils*. As a rule, they cover watershed plateaus, and in Polissia, loess isles. These soils are poor in nutrients and their physical properties are also inferior. Gleyed variations of podsolised soils form on loess-like deposits with a high underground water table (2–3 m).

Dark-chestnut residual solonetz soils are mainly to be found in the southern (dry) steppe subzone, predominantly on loess. Their profile reaches 50–55cm and a humus content of 2.5–3.0%.

Sod-clayey soils are associated with low-lying elements of topography such as watersheds and terraced plains in the mixed forest and forest steppe zones. They form in conditions of excess moisture supply, under grassy vegetation and contain 1.5–5.0% humus. Sod-alkali or solodised soils develop in the event of a salinisation of underground waters with soluble salts.

Sod-skeletal soils are weakly developed soils of an undifferentiated profile; they are encountered in the zone of crystalline rock outcrop of the Ukrainian Shield, have 2–3% humus content and are to be found under woodland. *Sod-forest soils* form on fluvial terraces originally covered by woods, in all natural zones. Amelioration is a basic precondition of their use for purposes of agricultural production.

Sod-carbonate soils form in the western part of the zone of mixed forests, with outcrops of chalk and marl. These are the most fertile soils in Polissia; they are either cultivated or found under woodland.

Meadow chernozem soils are encountered on terraces covered with loams developed on loess, in the forest steppe and steppe zones. They have fairly high humus content (6–8%) and are saturated with calcium and magnesium. *Meadow solonetz chernozem* variations are also widespread. In the northern forest steppe, salinisation is sodic in character, whilst in the southern portion it is of a sulphate nature. In the steppe zone, it is of a chloride-sulphate type.

Peaty soils and *bog-marsh* have developed in the floodplains of rivers and other depressions experiencing poor drainage in Polissia.

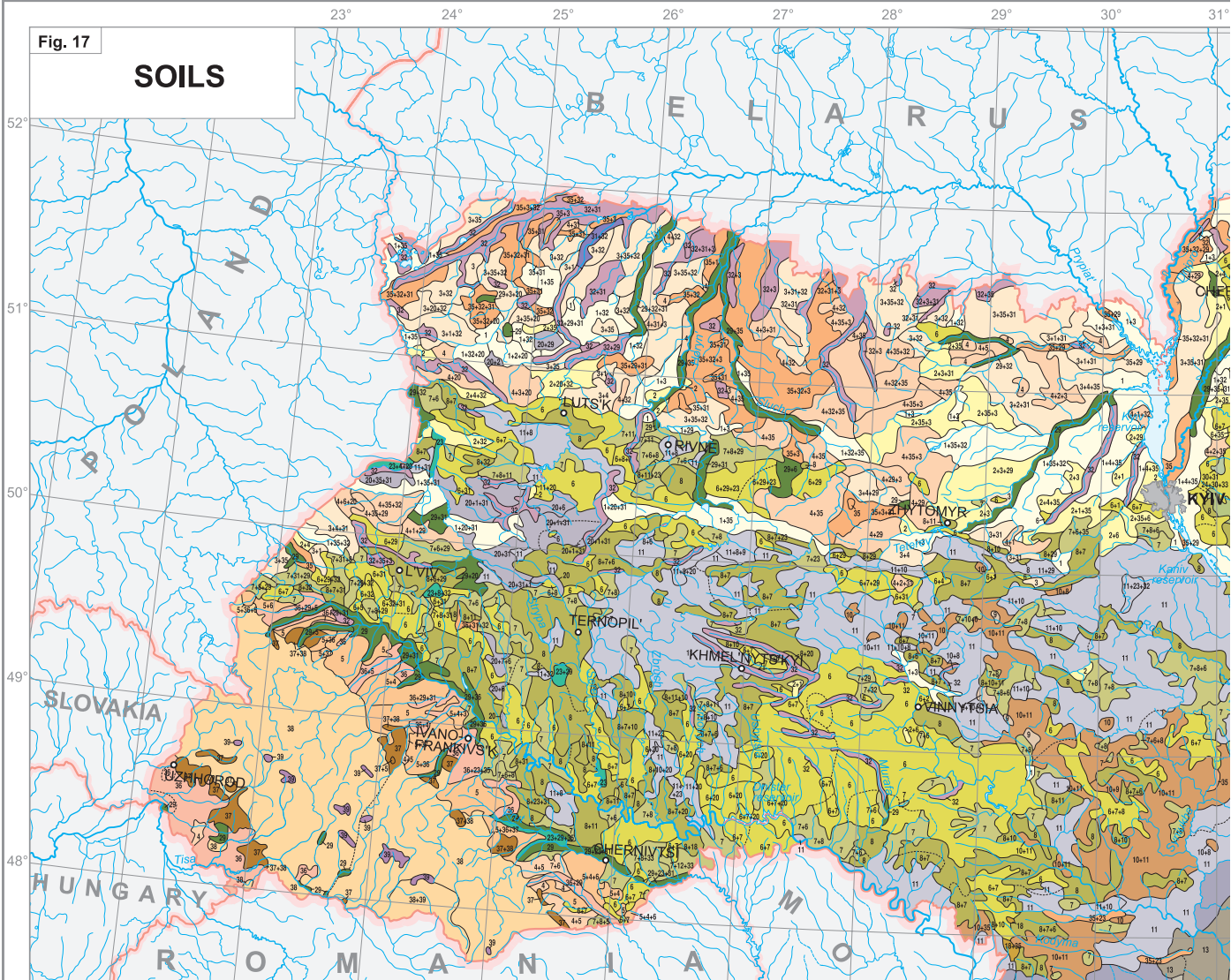
In the region of the Bay of Syvash and on the Kerch Peninsula (both in Crimea), along with the terraces of the Dnipro and other southern rivers, *solonetz soils* of low fertility are to be found.

In minor depressions (*pod*) of the steppe, *solodised soils* are encountered and are unsuitable for farming.

The Ukrainian Carpathians and Crimean Mountains display a marked vertical zonality in the soil cover. In the Ukrainian part of the Pannonian Lowland (Transcarpathian plain) *sod-*

Fig. 17

SOILS



Sod-podsolic soils on old alluvial and fluvio-glacial deposits

- 1 Sod-weakly podsolc sandy and clayey-sandy soils
- 2 Sod-moderately podsolc sandy soils

Sod-podsolic gleyed soils on old alluvial and fluvio-glacial deposits and moraines

- 3 Sod-weakly podsolc gleyed soils in combination with bog and marsh
- 4 Sod-moderately podsolc gleyed soils in combination with bog and marsh
- 5 Sod-moderately- and strongly podsolc surface-gleyed soils

Podsolised soils developed primarily on loess

- 6 Light-grey and gray podsolised soils
- 7 Dark-grey podsolised soils
- 8 Podsolised chernozems

Degraded soils developed primarily on loess

- 9 Dark-grey degraded soils
- 10 Degraded chernozems

Typical chernozems developed on loess

- 11 Typical chernozems with low or negligible humus content
- 12 Typical chernozems with medium humus content

Common chernozems developed on loess

- 13 Deep common chernozems with low or medium humus content
- 14 Common chernozems with medium humus content
- 15 Common chernozems with low humus content
- 16 Shallow common chernozems with low humus content

Southern chernozems developed on loess

- 17 Southern chernozems with low or negligible humus content

Chernozems on heavy clays

- 18 Chernozems on heavy clays, primarily solonchetic

Chernozems and sod-gravelly soils on eluvium of rock debris

- 19 Chernozems and sod-gravelly soils on eluvium of non-carbonate rock debris (sandstones and shale)
- 20 Chernozems and sod-gravelly soils on eluvium of carbonate rock debris (marls, chalk, limestone)

Residual solonchetic chernozems developed on loess

- 21 Residual solonchetic typical and common chernozems
- 22 Residual solonchetic southern chernozems

Meadow chernozems developed primarily on loess

- 23 Meadow chernozem soils
- 24 Meadow chernozem, surface solonchetic soils
- 25 Meadow chernozem, deeply solonchetic soils

Chestnut soils on loess

- 26 Dark-chestnut residual solonchetic soils
- 27 Dark-chestnut solonchetic soils
- 28 Solonchetic chestnut soils in complex with solonchets

Meadow soils developed on deluvial and alluvial deposits

- 29 Meadow soils
- 30 Meadow solonchetic soils

Bog soils on alluvial, deluvial, and fluvio-glacial deposits

- 31 Meadow-bog and swamp soils
- 32 Peatland and peat-bog soils

Solonchets

- 33 Solonchetic soils, primarily of solonchak type

Salinised soils

- 34 Meadow chernozem and sod-salinised gley soils and solods

Sod soils

- 35 Gleyed sod soils primarily developed on sand, clayey sand and sandy loam, in complex with sands of weak humus content
- 35a Non-gleyed sod soils primarily developed on sand and clayey sand, in complex with sands of weak humus content, occasionally with kuchugur (hummocky) relief and sandy chernozems
- 36 Podsolised sod-loamy soils and their gleyed variations

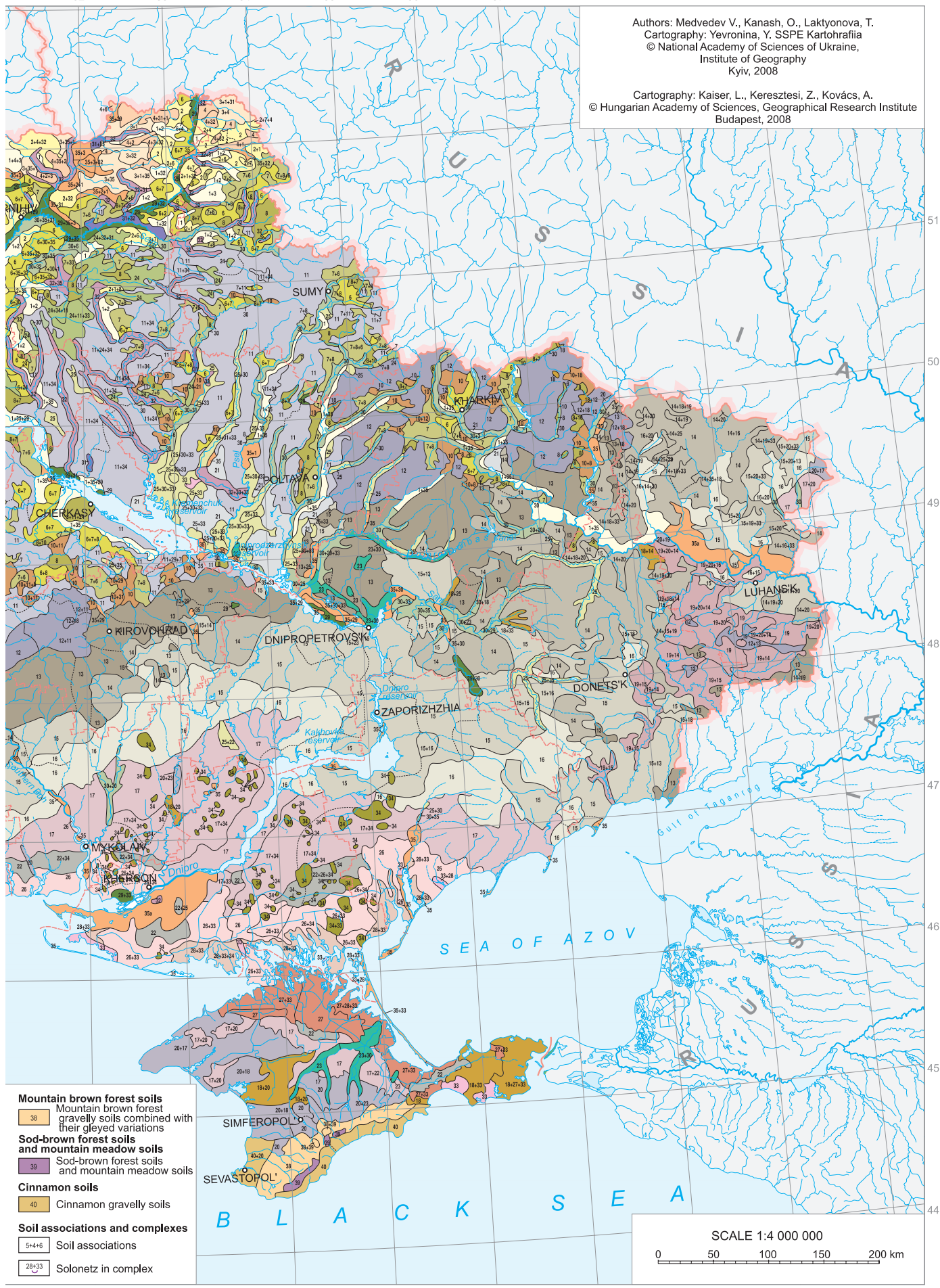
Podsolc brown forest soils primarily on deluvial deposits

- 37 Podsolc brown forest soils and their surface gleyed variations

32° 33° 34° 35° 36° 37°

Authors: Medvedev V., Kanash, O., Laktyonova, T.
Cartography: Yevronina, Y. SSPE Kartografiia
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Institute of Geography
Kyiv, 2008

Cartography: Kaiser, L., Keresztesi, Z., Kovács, A.
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Budapest, 2008



51°
50°
49°
48°
47°
46°
45°
44°

- Mountain brown forest soils**
38 Mountain brown forest
gravelly soils combined with
their gleyed variations
- Sod-brown forest soils
and mountain meadow soils**
39 Sod-brown forest soils
and mountain meadow soils
- Cinnamon soils**
40 Cinnamon gravelly soils
- Soil associations and complexes**
5+4+6 Soil associations
28+33 Solonetz in complex

33° East of Greenwich 34° 35° 36° 37°

SCALE 1:4 000 000

0 50 100 150 200 km

gley soils are found; the foothills harbour *sod-podsolic* and *surface-gleyed soils*; *podsolised brown forest soils* and *surface-gleyed soils* are found on the piedmonts of the volcanic range; and *mountain brown forest soils* and *sod-brown forest soils* in the mountainous areas of the Carpathians, developed on eluvial-deluvial deposits under woodland and grassland.

In the Crimean forest zone, on the northern aspect slopes at altitudes over 300 m, and on southern aspects over 400–600 m, *mountain brown forest soils* and *sod-brown forest soils* are to be found. Their humus content varies between 4 and 6%. In the lower parts of the slopes of the main ridge of the Crimean Mountains, *stony cinnamon mountain soils* are found up to an altitude of 400–600 m. The soils of Crimea are under intense cultivation: valuable berries, grapes, oil-seeds and tobacco are grown.

Vegetation. As far as its present-day vegetation is concerned, nature has richly endowed Ukraine, and the country occupies a prominent place in Europe. Due to its unique geographical location, Ukraine was the venue of the formation of florocomplexes and coenocomplexes which were derivatives from various centres.

Flora of superior and inferior plants includes more than 25 thousand species, in addition to over 40 domesticated species. The territory of Ukraine harbours several differing environments for plants: forests, steppes, meadows, swamps and aquatic vegetation in lakes and reservoirs. Natural vegetation occupies ca. 30% of the country's territory, even though it has undergone intense human-induced transformation. Going from the west to the east, i.e. from the Central European province to the East European one, a strengthening Continental climate can be observed. From the north to the south, with the improvement in climatic conditions the broad-leaved, forest steppe, steppe and Sub-Mediterranean zones follow each other.

The forest zone is represented by Central European, East European and Carpathian-Alpine geobotanical provinces, whereas the forest steppe zone includes Pannonian, Ukrainian and Central Russian geobotanical provinces.

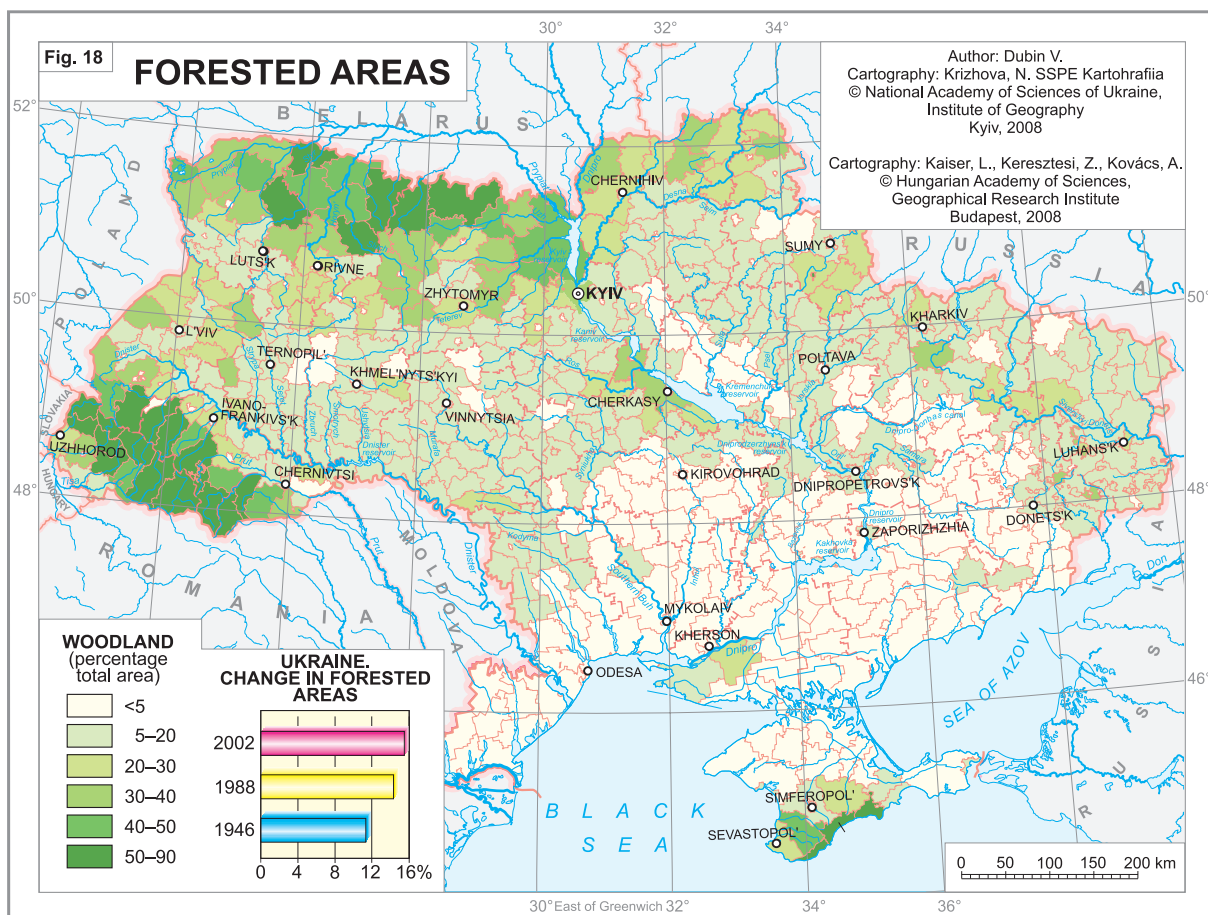
Typical forests in Ukraine are: bor (pine grove), subor, sugrudok, grud (oak–hornbeam forests), dubrava, buchina (beech grove), ramen' and suramen'. Woodland occupies 15.9% of the country's territory (Figure 18). The basic species are pine, spruce, fir, larch, beech, oak, hornbeam,

elm, linden, ash, maple, birch, poplar and alder. In the zone of mixed forests and on the sandy terraces of forest steppe, common pine is the most widespread. In the Ukrainian Carpathians pine groves are scarce, whereas in the Crimean Mountains they reach up to 1,000–1,300 m. Spruce (common i.e. European and mountain) is less frequent here, but in the Carpathians they expand up to 1,450–1,650 m. In the latter, and in Roztochchia, fir is frequently encountered. Beech is widespread: European beech grows at altitudes of 500–1,200 m in the Carpathians and Taurian beech is found up to 1,300 m in the Crimean Mountains. Beech groves occupy the plateaus in Podillia as mixed forests, with abundant hornbeam, ash, maple, and linden. On the Ukrainian plains and in the mountains up to 900 m, common oak and rocky oak are to be found. Fluffy oak grows in the Crimean Mountains. Oak groves are typical of the forest steppe zone, the piedmonts of the Carpathians and the plains of Transcarpathia. Hornbeam–oak forests are found on the right bank forest steppe zone, in the following composition: common oak, common hornbeam, ash, heart-leaf linden, maple, elm, birch and black alder. In the mixed forest zone there are birch forests, also occurring in some places within the forest steppe and steppe zones. Bearded birch dominates, mixed with pine, oak and hornbeam. On the flood plains below river terraces and with bog soils, the dominant species are black alder mixed with pubescent birch, common pine, oak and hornbeam.

Steppe vegetation is represented in the forest steppe and steppe zones by grassy vegetation such as feather-grass, fescue-grass and clover. Grasses dominate in a typical steppe environment. Steppes mainly composed of fescue and feather-grass, survive in the Askania-Nova nature reserve and in Crimea. Sagebrush-fescue steppes (feather-grass, fescue and wheat-grass) are to be found along the coastal plains of the Black Sea and Sea of Azov, and in the vicinity of the Bay of Syvash and Kerch Peninsula. Categorized by location, meadow vegetation is subdivided into flood-plain, dry valley, lowland and mountain meadows.

Three types of swamps are encountered in Ukraine: eutrophic swamps, mesotrophic (transitory) bogs and oligotrophic (high) moors.

Human impact caused by economic activities, has resulted in a considerable shift towards the retreat of wild plants and plant communities,



along with the appearance of a great amount of adventive species, alien to natural phytoceenoses and contaminating the genetic fund.

The conservation of the diversity in flora is one of the current tasks in Ukraine. Presently, 541 plant and mushroom species needing protection are recorded in the Red Book of Ukraine and the Green Book of Ukraine contains 127 syntaxa, i.e. plant communities of different ranks with a relevant protection regime.

Animal wildlife. The number of species that exist in Ukraine are witness to the abundance and diversity of fauna. There are 117 mammals, 400 birds, around 200 types of fish, 21 reptiles, 17 amphibia, 20 crustaceans, ca. 25 thousand insects, etc. The combined total of differing animal species is estimated to be 44,000.

Over half of the country's territory belongs to the Holarctic region, and within that to the boreal European–Siberian zoogeographic subregion. The Crimean Mountains, the southern coast of Crimea and Pannonian lowland are part of the Mediterranean–Central Asian zoogeographic subregion, similar to the fauna of continental standing waters, Black Sea and Sea of Azov.

The following animals are encountered in almost all Ukrainian biotopes.

Mammals: common hedgehog, mole (with the exception of the steppe and Crimean Mountains), shrew (common, pygmy, white-toothed and lesser), bat particoloured, brown hare, common rat, mice (common field-mouse and door mouse), hamster, common vole, common red fox, wolf, raccoon dog, stone marten, badger and wild boar.

Birds: great crested gebe, common heron, mallard, garganey, kestrel, quail, corncrake, black-headed gull, turtle-dove, cuckoo, black swift, woodpecker, sky lark, house sparrow and tree sparrow, raven, hooded crow, magpie, rook, great tit, thrush nightingale, yellow bunting, starling, sand martin and swallow.

Reptiles: sand lizard, grass snake and smooth snake.

Amphibia: marsh frog, pool frog (except for Crimea), Altai brown frog (except for the dry steppe), tree frog, toad and common toad (except for Crimea and the arid steppe).

In biotopes that have suffered profound change as a result of human impact, mammal

species such as mice and the grey hamster are frequently encountered, along with widespread birds such as kite, partridge, great bustard, crane, skylark, wagtail and corn bunting.

Rare species of mammals and those on the verge of extinction, entered into the Red Book of Ukraine are stoat, southern birch mouse, long-eared hedgehog, desman, alpine shrew, horseshoe bat (greater and lesser), noctule (lesser and giant), mountain hare, European souslik, great jerboa, European mink, wild cat, lynx and bison. Fish that appear in the Red Book are: sturgeon (sterlet, great white sturgeon), salmon and trout (salmon-trout, Danube trout and European grayling). Bison, wild boar (Central Asian and Far Eastern subspecies), mountain hare, rabbit, muskrat, and the red squirrel belong to the acclimatised and re-acclimatised animal species. The most frequently hunted animals are the wild boar, moose elk, red deer, European roe-deer, brown hare and the common red fox. Their stock has lessened recently.

Landscape diversity and physico-geographical subdivision of Ukraine. The main components of the natural environment characterised above (relief, climate, waters, soils, flora and fauna) are in a state of permanent interrelationship and interaction, thus forming geographical landscapes which represent natural territorial complexes and intricate geosystems.

During the last decades of the 20th and early 21st century, geographical science has paid increasing attention to the study of landscapes and their components and complexes, including those within Ukraine (*Figure 19*). This can primarily be attributed to the practical relevance of the use of natural resources and ecological problems that have recently emerged.

Large-scale investigations into the morphology, geophysics and geochemistry of landscapes have been performed, landscape mapping and classification has been accomplished, and methodological and applied issues have come to the fore. Further, physico-geographical subdivision of the country's territory was carried out, into regions and administrative units (raions). A series of publications and landscape maps have been compiled with respect to applied problems, related to agriculture and silviculture, regional planning, and also to the solution of radio-ecological issues in the aftermath of the Chernobyl' nuclear disaster.

A characteristic feature of Ukrainian natural territorial complexes is their landscape-ty-

pological diversity and intricate spatial pattern. This is a consequence of: the country's location within three physico-geographical macroregions (East European Plain, Ukrainian Carpathians, Crimean Mountains) and four latitudinal zones; a specific vertical zonation in the mountains; a complex geological build-up (the presence of different geostructures and formations from various geological times); spatial differentiation of recent crustal movements; the origin of landscapes, i.e. an inheritance of relic landscapes from ancient glaciations; and a perpetual transformation of natural landscapes under the impact of human activity.

The East European Plain is dominated by plain landscapes occupying over 94% of the country's territory, whereas mountainous landscapes are typical of the Ukrainian Carpathians and Crimean Mountains. Zonation is a primary characteristic feature of plain landscapes. Examples of various natural zones of the Earth's temperate belt are found in Ukraine: mixed coniferous-deciduous forests, broad-leaved forests, forest steppes and steppes. Major factors decisive in the types of zonation are heat, moisture balance and the parent rocks the soils have been formed upon.

Recently, Ukrainian geographers have come to the conclusion that broad-leaved forests in the west of the country are the continuation of a similar kind of woodland zone extending from western Europe.

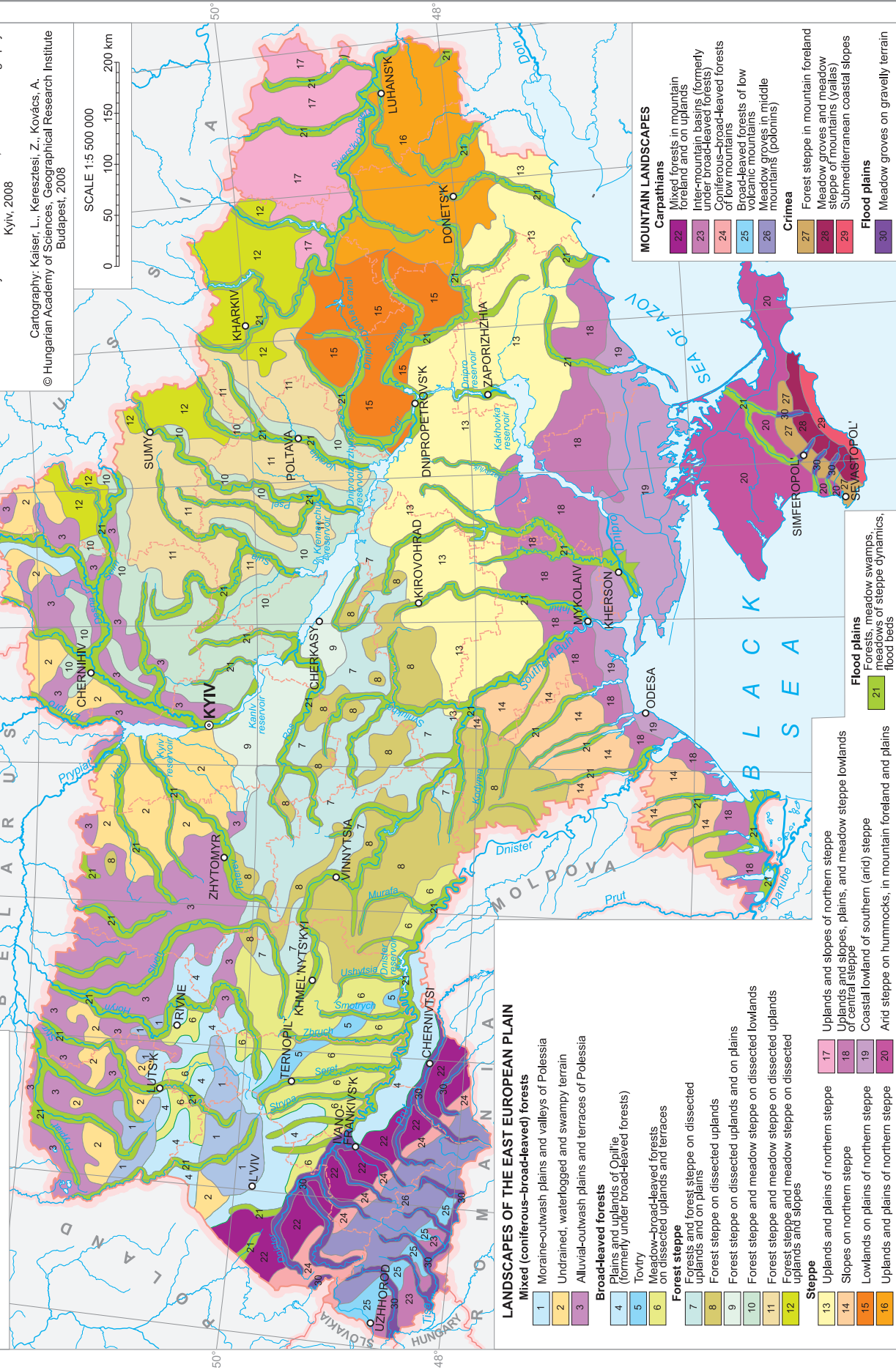
Mountainous landscapes occupy over 5% of the country's territory and the distribution shows a vertical zonation. In the Ukrainian Carpathians forests prevail: Oak is dominant on the foothills; a prevalence of beech on low mountains; fir mixing with beech and meadow landscapes on middle mountains; pine with shrubs at the sub-alpine level; and grass vegetation with shrubs at alpine level.

Examining the landscape structure of the Crimean Mountains, forest-meadow landscapes can be observed with mixed coniferous-deciduous forests, karst landscapes on the yaila, and subtropical landscapes of a Mediterranean type along the southern coasts.

A fundamental principle of classification and typology in modern landscape science is an approach which considers the genesis of a landscape as the first step, further taking into account geophysical and geochemical properties, and current physico-geographical processes.

Fig. 19

LANDSCAPE TYPES



Authors: Marynych, O., Petrenko, O.
 Cartography: Krizhova, N.
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Cartography: Kaiser, L., Keresztesi, Z., Kovács, A.
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SCALE 1:5 500 000

0 50 100 150 200 km

LANDSCAPES OF THE EAST EUROPEAN PLAIN

- Mixed (coniferous-broad-leaved) forests**
- 1 Moraine-outwash plains and valleys of Polesia
 - 2 Undrained, waterlogged and swampy terrain
 - 3 Alluvial-outwash plains and terraces of Polesia

- Broad-leaved forests**
- 4 Plains and uplands of Oplie (formerly under broad-leaved forests)
 - 5 Tovtry
 - 6 Meadow-broad-leaved forests on dissected uplands and terraces

- Forest steppe**
- 7 Forests and forest steppe on dissected uplands and on plains
 - 8 Forest steppe on dissected uplands
 - 9 Forest steppe on dissected uplands and on plains
 - 10 Forest steppe and meadow steppe on dissected lowlands
 - 11 Forest steppe and meadow steppe on dissected uplands
 - 12 Forest steppe and meadow steppe on dissected uplands and slopes

- Steppe**
- 13 Uplands and plains of northern steppe
 - 14 Slopes on northern steppe
 - 15 Lowlands on plains of northern steppe
 - 16 Uplands and plains of northern steppe

- 17 Uplands and slopes of northern steppe
- 18 Uplands and slopes, plains, and meadow steppe lowlands of central steppe
- 19 Coastal lowland of southern (arid) steppe
- 20 Arid steppe on hummocks, in mountain foreland and plains

- Flood plains**
- 21 Forests, meadow swamps, meadows of steppe dynamics, flood beds

MOUNTAIN LANDSCAPES

Carpathians

- 22 Mixed forests in mountain foreland and on uplands
- 23 Inter-mountain basins (formerly under broad-leaved forests)
- 24 Coniferous-broad-leaved forests of low mountains
- 25 Broad-leaved forests of low volcanic mountains
- 26 Meadow groves in middle mountains (polonins)

Crimea

- 27 Forest steppe in mountain foreland
- 28 Meadow groves and meadow steppe of mountains (yalias)
- 29 Submediterranean coastal slopes

Flood plains

- 30 Meadow groves on gravelly terrain

Human activity has had a major impact on changes in the composition of natural landscapes over the course of Ukraine's history. Farming, silviculture, amelioration measures, various industrial activities (with a special reference to mining), the emergence of settlements, hydrotechnical construction, and the development of transport networks, recreational facilities and warfare have caused the most significant and far-reaching effects. Landscapes that have remained intact, or have been transformed only slightly occupy some 15–20% of the country's territory.

The classification of landscapes reflects an overall view of the basic components of the natural environment: relief and landforms, climatic conditions, soil cover and the characteristic features of natural vegetation.

The results of the recent subdivision exercise show that there are 206 landscape units (Table 2) across the country. An integrated study of landscapes and their mapping served as a basis for the identification of physico-geographical raions, reflecting spatial differentiation and allowing subdivision into actual landscape units. The subdivision into raions has an importance for the accomplishment of a rational and balanced use of landscapes in practice. A landscape-genetic principle is inherent in the basis of raion demarcation, taking into consideration the differentiation of basic components of the natural

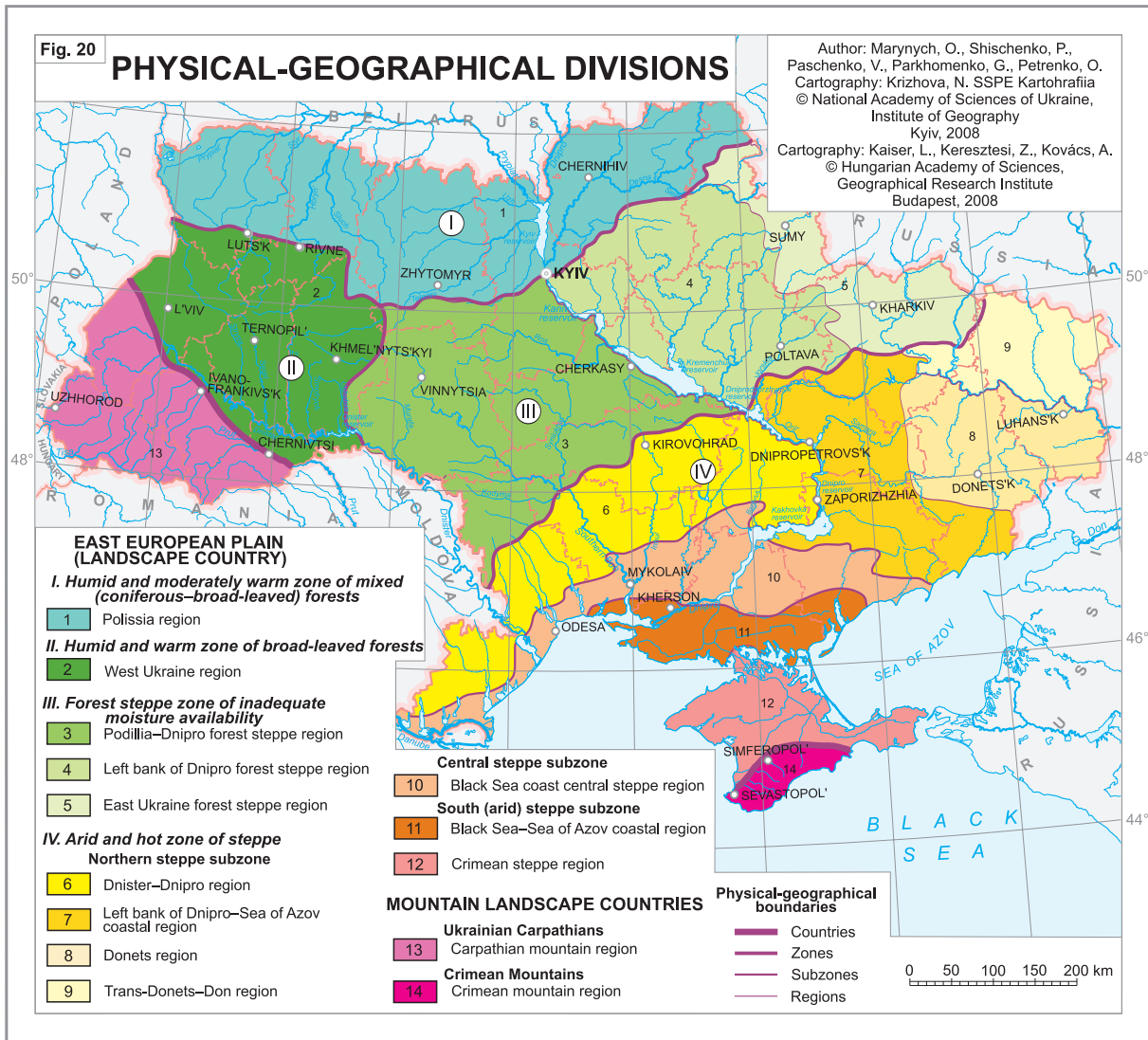
environment. On Figure 20, the boundaries of zonal landscape units (zones and subzones) and those of the taxonomic units (macroregion and region) are shown. Territorial units are closely related to typological entities. Macroregions correspond to landscape classes; zones and subzones are the counterparts of types and subtypes. On the map showing physico-geographical subdivision, there are 3 macroregions, 4 zones, 3 subzones and 14 regions.

Ecological situation. The assessment of the living conditions of population is considered an integral part of environmental evaluation, most often regarded from the economic aspect as an impact of interactions between society and nature. Actually it is the synergetic representation of the cumulative impact of all kinds of technogeneous pressure on the landscapes. When performing a synergetic assessment of living conditions, beside the occurrence of polluted natural components, some other aspects also should be taken into account. Natural hazards, heat and moisture availability, duration of the frost-free period etc. might have a direct or indirect effect on ecological situation.

For a long time the ecological consequences of economic development had not been realised or had been ignored by the states all over the world. This negative approach had led to dramatic deterioration of the quality of the physical environment, pollution or contamination by

Table 2. *Distribution of landscape units within physico-geographical zones and regions of Ukraine*

Physico-geographical macroregion	Physico-geographical zone	Physico-geographical region	Number of landscape units
East European Plain	1. Mixed forests	1. Polissia	31
	3. Forest steppe	2. West Ukraine	16
		3. Podillia–Dnipro	22
		4. Left Bank of Dnipro	12
	4. Steppe	5. East Ukraine	14
		6. Dnister–Dnipro	9
		7. Left Bank of Dnipro and Coast of Sea of Azov	13
		8. Donets	10
		9. Trans-Donets–Don	8
		10. Black Sea coast	16
		11. Coast of Black Sea and Sea of Azov	12
	Mountains	Vertical zonality	12. Crimean steppe
13. Ukrainian Carpathians			21
Total	4	14	206



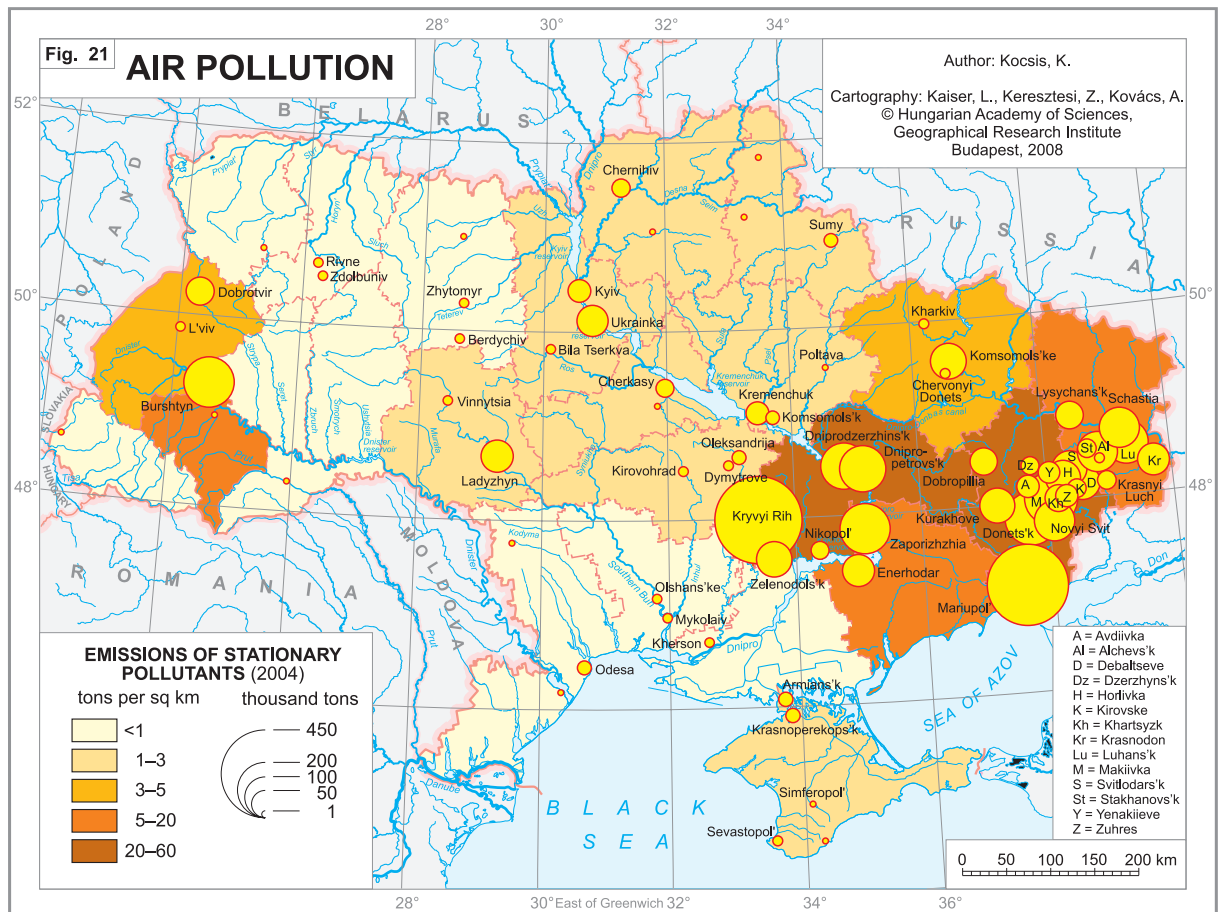
wastes as by-products of human economic activities (Figure 21). These issues heavily affected Ukraine as well. Recently, governmental agencies, corporate management, and the population have made efforts to reduce anthropogenic pressure on the physical environment, which still remains at a significant scale. This situation mainly stems from the obsolete technologies of production and outdated waste treatment facilities.

On the territory of Ukraine the total emission of pollutants and contaminants per capita amounted to ca 100 kilograms in 2005. The highest emissions were typical of the stationary polluters in the highly industrialized oblasts of the country: Donetsk, Dnipropetrovsk, Luhansk, Zaporizhzhia (Figure 22). These regions are dominated by iron and steel and chemical industries and manufacturing as well as coal and metal ores mining. In several oblasts transport emis-

sions are the main sources of pollution; in 19 of them the emission volumes of exhaust gases even exceed those from stationary sources.

As a consequence of an ongoing negative trend of growing specific use of freshwater resources (per product unit) and a concurrent contamination of water bodies with insufficiently treated waste water, an ecological crisis situation has emerged in the basins of Northern (Sivers'kyi) Donets', water courses flowing to the Sea of Azov, and in some tributaries of Dnister, Dnipro and Western (Zakhodnyi) Buh. During recent years waterlogged surfaces have become a widespread phenomenon in Dnipropetrovsk, Donetsk, Odesa and Kherson oblasts. Extremely high groundwater table is typical over ca 17% of the country's territory.

Long-lasting intense cultivation of soils and cuts in the financial sources for soil conser-



vation have led to negative processes such as erosion, secondary salinization, waterlogging, and the loss of humus reserves. These processes have an extremely adverse impact on the living conditions of population.

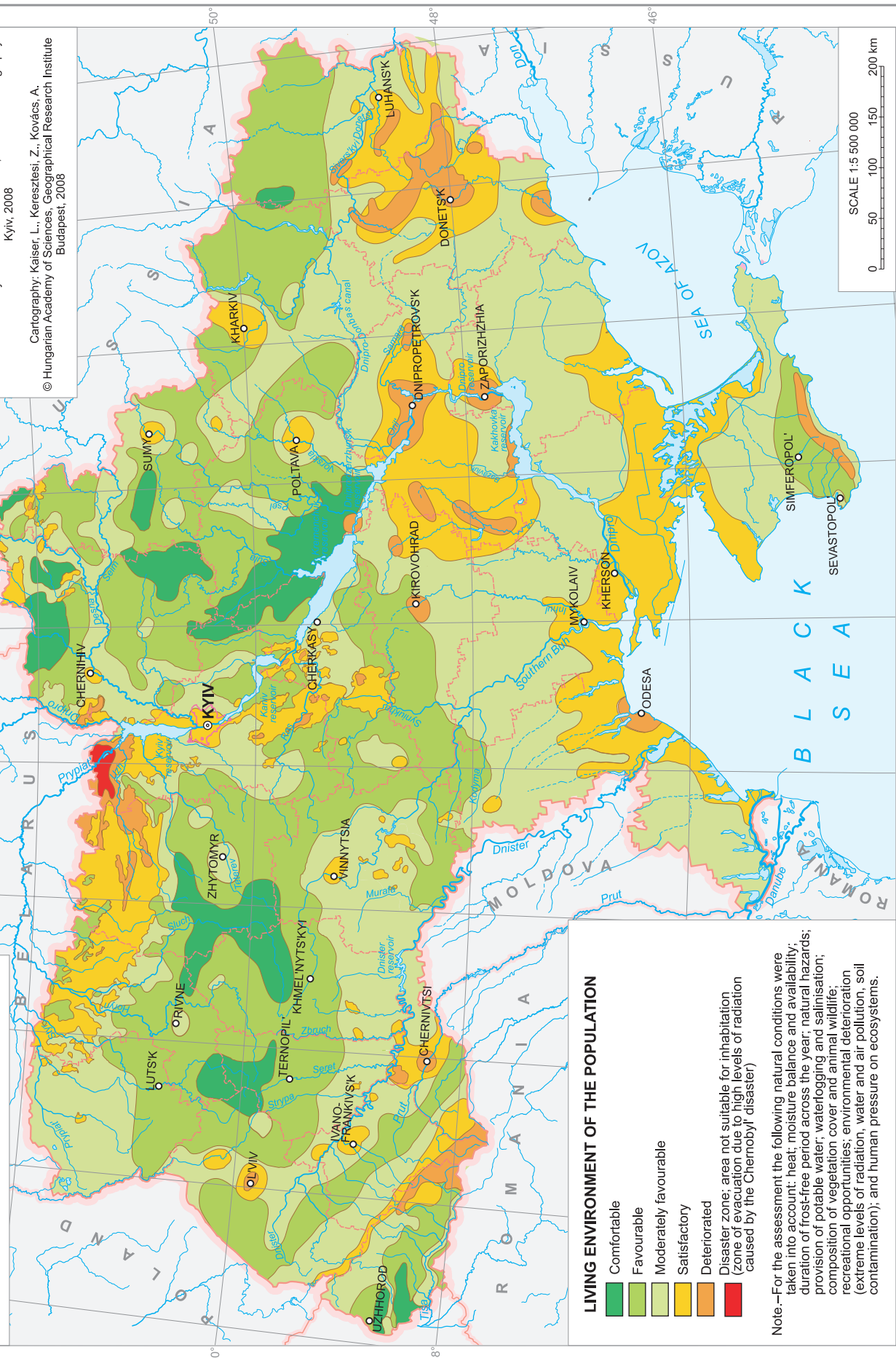
As a consequence of the Chernobyl disaster (April 26, 1986) radioactive contamination extends over a land area of 54 thousand square km (including 25 thousand square km of woodland). After this accident, the most devastating in the history of nuclear power production, 336,000 people had to be evacuated immediately or resettled later, including ca. 50,000 persons from Prypiat' town, located close to the power plant. The number of Soviet citizens exposed to radiation was estimated at 6.6 million; including 9,000 victims who presumably died of cancer (IAEA Report). Due to the prevailing meteorological conditions of that time the radioactive fall-out (e.g. caesium-137, iodine-131, strontium-90) seriously affected a horseshoe shaped area in the west of Ukraine (Polissia, Kyiv–Vinnytsia region, Middle-Dnister area). An overwhelming majority of the persons registered as victims of the Chernobyl disaster (2.6 million in

2005) can be found in the area mentioned above (Figure 23). Following the establishment of the Chernobyl Shelter Fund (1997, Denver G7 summit) a Shelter Implementation Plan was set up to ensure ecologically safe conditions on the Chernobyl site (e.g. stabilization of the sarcophagus, construction of a New Safe Confinement). The European Community contributed €621.1 million to the Chernobyl Shelter Fund between 1991 and 2006.

Nature conservation areas. There are many unique and picturesque places of high aesthetic value in Ukraine. They are encountered in each region of the country, and a number of them are described in literary works, portrayed on paintings or represented in musical compositions. Many of these objects are protected as part of natural heritage and declared nature reserves (Figure 24). Some of these places characteristic for certain zones and regions are mentioned below. In the environs of Kyiv it is Koncha-Zaspa, Puscha-Voditsa, Tripolie. On the Polissia there are hundreds of beautiful lakes, such as Svitiaz' of karst origin. Kaniv urochishches within forest steppe in the surroundings of Cherkasy are

Fig. 22

ECOLOGICAL SITUATION



LIVING ENVIRONMENT OF THE POPULATION

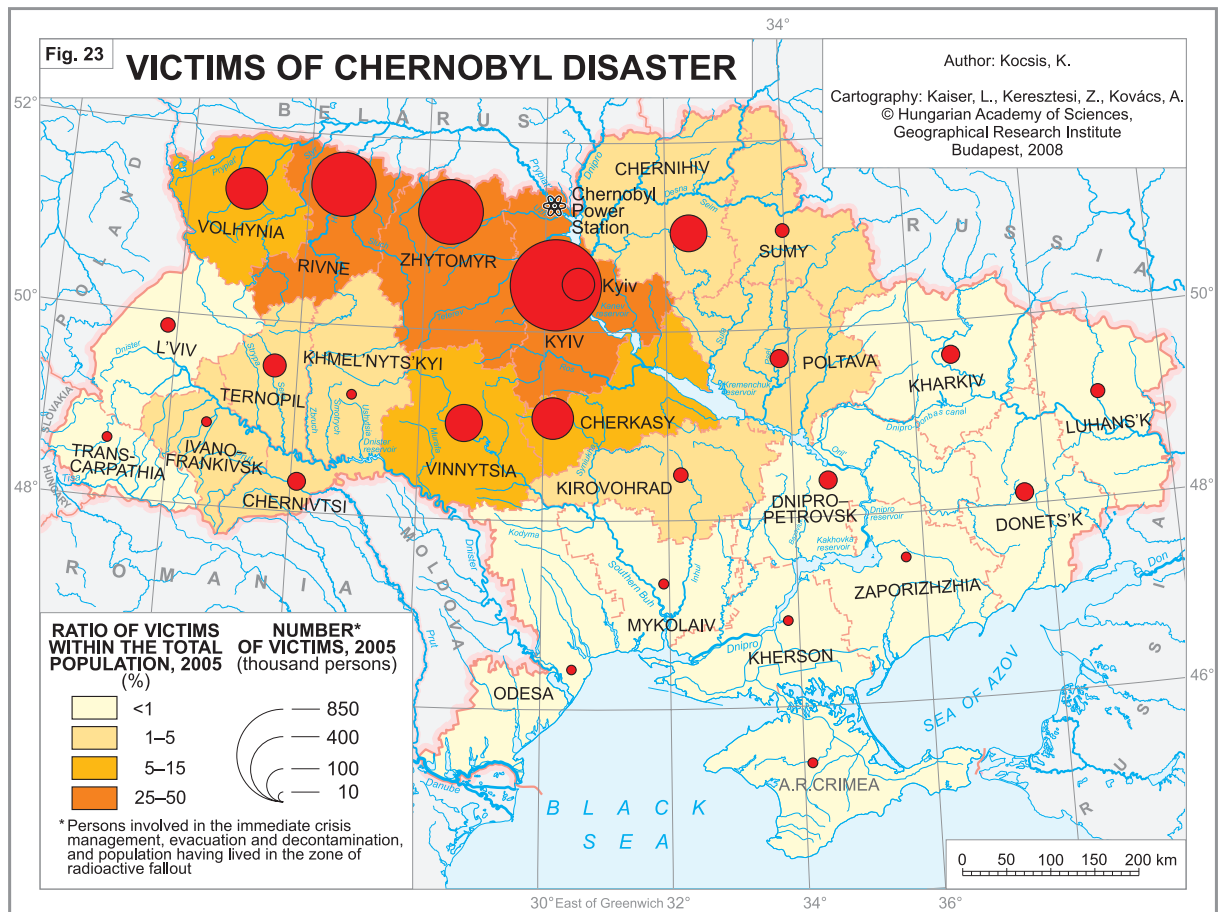
- Comfortable
- Favourable
- Moderately favourable
- Satisfactory
- Deteriorated
- Disaster zone: area not suitable for inhabitation (zone of evacuation due to high levels of radiation caused by the Chernobyl disaster)

Note.—For the assessment the following natural conditions were taken into account: heat; moisture balance and availability; duration of frost-free period across the year; natural hazards; duration of potable water; waterlogging and salinisation; composition of vegetation cover and animal wildlife; recreational opportunities; environmental deterioration (extreme levels of radiation, water and air pollution, soil contamination); and human pressure on ecosystems.

Authors: Rudenko, L., Razov, V., Baranovskiy, V.
 Cartography: Prokop'eva, V. SSPE Kartohrafiia
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Cartography: Kaiser, L., Keresztesi, Z., Kovács, A.
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depicted in Taras Shevchenko's poetry, landscapes around Chernihiv along Desna river are shown by Olikssandr Dovzhenko, wide Taurian steppes with the celebrated Askania-Nova Reserve appear in the works by Oles' Honchar. Ancient coral formations of Neogene seas, locally called tolters (medobors), stretch over Podillia. Subtropical vegetation and mountain waterfalls on the southern coasts of Crimea are famous far beyond the borders of Ukraine. The poet Ivan Franko portrayed the majestic peaks of the picturesque forested Carpathians, the volcanic range and mountain meadows (polonins). There are a number of wonderful places on the Black Sea and Sea of Azov coasts. Physico-geographical regions reflect a diversity of natural landscapes in Ukraine to be cherished and preserved for the forthcoming generations.

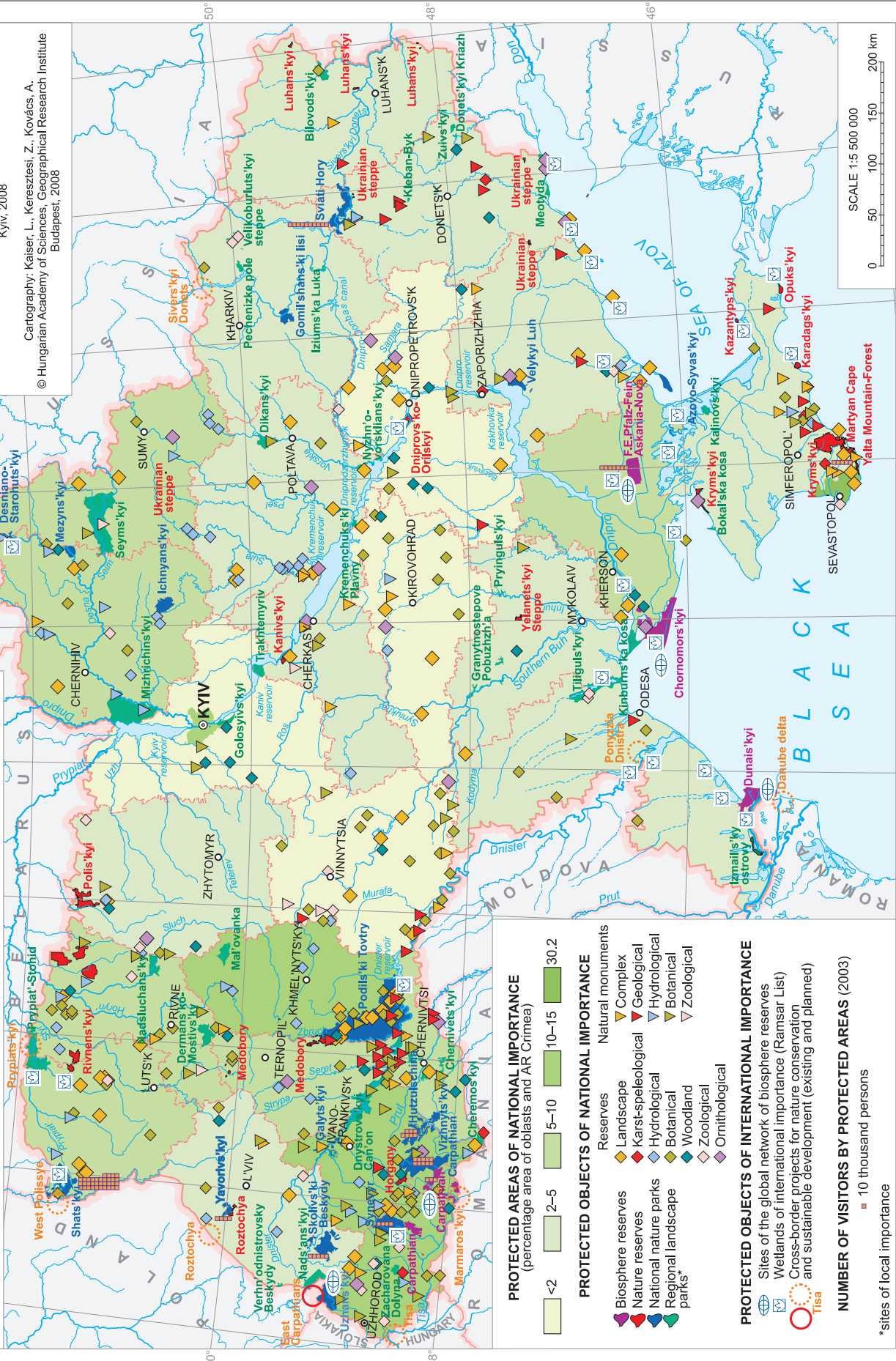
The fond of *natural reserves* in Ukraine constitutes 2.8 million hectares, 4.7% of the state territory (As January 1, 2007). Out of

this area 7.9% is covered by four *biosphere reserves* (Askania-Nova, Black Sea, Carpathian, Danubian), 5.8% by 17 *natural reserves* (e.g. Crimean, Gorgans, Polissian, Roztochchia, Ukrainian Steppe), 25.1% by 19 *national natural parks* (e.g. Azovo-Syvashian, Carpathian, Desna-Stara Huta, Podillian Tovtry, Shats'kyi, Sviati Hory) and 19.8% by 46 *regional landscape parks* (e.g. Kinburns'ka kosa, Mizhrichyns'kyi, Seimskyi, Tylihul's'kyi). Among them the most visited by tourists are the Shats'kyi, Carpathian, and Sviati Hory national parks and the Askania-Nova biosphere-reserve (100–300 thousand visitors per year). In addition, there are 2,693 partial (e.g. landscape, hydrological, botanical, zoological) reserves, 3,057 monuments of nature or natural sights, 618 botanical and zoological parks, dendroparks, and parks featuring landscape architecture and 739 protected woodland features.

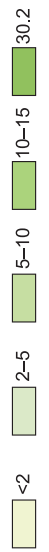
Fig. 24

PROTECTED AREAS OF NATIONAL IMPORTANCE

Authors: Liaschenko, D., Voznil, Yu.
 Cartography: Prokop'eva, V. SSPE Kartohrafiia
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PROTECTED AREAS OF NATIONAL IMPORTANCE
 (percentage area of oblasts and AR Crimea)



PROTECTED OBJECTS OF NATIONAL IMPORTANCE

- Reserves
 - ◆ Biosphere reserves
 - ◆ Landscape reserves
 - ◆ Nature reserves
 - ◆ National nature parks
 - ◆ Regional landscape parks*
- Natural monuments
 - ◆ Complex
 - ◆ Karst-speleological
 - ◆ Hydrological
 - ◆ Botanical
 - ◆ Woodland
 - ◆ Zoological
 - ◆ Ornithological

PROTECTED OBJECTS OF INTERNATIONAL IMPORTANCE

- ◆ Sites of the global network of biosphere reserves
- ◆ Wetlands of international importance (Ramsar List)
- ◆ Cross-border projects for nature conservation and sustainable development (existing and planned)
- ◆ IJSSA

NUMBER OF VISITORS BY PROTECTED AREAS (2003)

- 10 thousand persons
- *sites of local importance

