REGIONAL DISTRIBUTION OF RIVERS AND STREAMS IN EUROPE

V.I. Babkin
Doctor of Geographic Sciences, State Hydrological Institute, St. Petersburg, Russia

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Summary

The continent of Europe is a part of Eurasia. Along with adjacent islands it occupies 10.5 mln km^2 of the Earth`s area. Waters of the Atlantic and Arctic Oceans surround Europe. The Mediterranean, Baltic and Black Seas deeply jag the land of the continent. There is also the world largest closed lake – the Caspian Sea. The average annual runoff of all European rivers including those on the islands is 2900 km^3 .

In terms of water content, the largest rivers are the Volga, Danube, Pechora, Severnaya Dvina, Rhine, and Neva.

Conventionally, Europe is divided into five natural-economic regions. North and Central Europe, and the northern part of the former Soviet Union yield the largest runoff volumes. The largest water availability of population is in North Europe and northern slope of the European part of the former Soviet Union.

1. Introduction

The area of Europe including the adjacent islands is 10.5 mln km^2. Europe is in the Northern Hemisphere. The northernmost point of the continent is Nordkapp i.e. North Cape (71^0 08`N) located in North Norway. The southernmost point of the continent is Tanifa in Spain ($36^0$ N). The westernmost point is Cape Roc ($9^0$ 34`W), and easternmost – the point of the Ural Mountains (67^0 20`E). The length of the continent from north to south is 3895 km, and from west to east – 5250 km. A deep penetration of seas (Mediterranean, Baltic and Black) and sea gulfs the land and very jagged coastline by length of 38,000 km are the most important features of the continent Europe.
In the west, the Atlantic Ocean washes the continent. In the north, there is the North Sea connected via the Dutch Strait to the interior Baltic Sea. The North Sea converts into the Norway Sea located along the coastline of the Scandinavian Peninsula. In the northern part of the Atlantic Ocean washing Europe, there is the powerful warm current Gulf Stream that exerts a pronounced effect on climate formation on the continent. The Mediterranean Sea connected to the Atlantic Ocean via the Gibraltar Strait washes South Europe. The Barents Sea – a part of the Arctic Ocean – washes the northern part of the continent

A comparatively large number of islands belong to Europe. Among them the largest are: British Island, Iceland, and Ireland located near the western coast. In the Mediterranean Sea, the largest islands are Sicily, Sardinia, Corsica, and Crete. In the Arctic Ocean – Novaya Zemlya, Vaigatch, Spitsbergen, and Franz Josef Land. The area of all islands adjacent to Europe is about 700,000 km^2 .

The continent of Europe is divided into runoff slopes: the Arctic Ocean slope (1,400,000 km^2) and the Atlantic Ocean one (6,200,000 km^2). The region of endorheic drainage, i.e. the Caspian Sea basin, occupies about 2,200,000 km^2 of the territory of Europe.

Europe is one of the densely populated continents on the terrestrial globe. In 1994, population of Europe numbered 680.5 mln people.

2. Factors determining the development of hydrographic network and hydrological river cycle at the present time.

2.1 Relief.

The relief of Europe is very diverse. An alteration of mountain ridges and valleys is typical of the continent. On the Iberian Peninsula, there is a highland with high ridges

and flat plains. In the northern part of the peninsula, there are the Pyrnees Mountains, 3404 m high. In the south, there are the Andalusian Mountains, 3481 m the highest. The Appenine Ridge stretches along the Apennine Peninsula. The highest peak of this ridge reaches 2921 m. In southeast Europe, the Balkan Peninsula is partly separated from the rest of Europe by the Balkan Mountains (Stara Planina). The Dinara Mountains form a stripe in the western part of the peninsula, where karst phenomena are widespread, which causes a considerable decrease in surface runoff and increase in ground waters. In Northern Europe, there is the Scandinavian highland. The Utunheimen – the highest peak of this highland – is 2481 m.

South of the Scandinavian highland, there is a wide band of low lands and vast depressions. They occupy southeastern England, the northern part of France, Belgium, Denmark, The Netherlands, the northern part of Germany, most of Poland, Finland, South Sweden, and the northern half of the East European Plain. South of this lowland band, there is a belt of middle-high massifs and mountain ridges. Among them the largest are: the Central French massif, 1886 m high, and the Czech (Bohemia) massif, up to 1600 m high.

The highest mountains in Europe (excluding the Great Caucusus) are the Alps. The Mont Blanc, 4810 m above sea level, is the highest mountain of the Alps. The total area of the Alps Mountains is about 200,000 km^2. The Carpathian Mountains are a continuation of the Alps. The Vienna depression separates these two mountain massifs. The alluvial lowlands Vienna-Padan, Middle-Danube, and Lower-Danube adjoin the Alps and the Carpathians. Southern Europe is a region of intensive tectonic movements, frequent earthquakes, and modern volcanism (active volcanoes are the Etna, Vesuvius, etc.).

As to the orographic structure, the relief of East Europe is less jagged as compared to West Europe.

The Russian Plain, about 4 mln km^2 in area, occupies the major portion of the territory of East Europe. This plain stretches from the Arctic Ocean to the Black and Caspian Seas, and from the western border of the Baltic countries in East Europe to the Ural Mountains. The Russian Platform is laid down by such diverse elements as sheets, anticlises, syneclises, and other smaller structures, therefore the Russian Plain is covered with alternating hilly and flat lands and lowlands. The Ukrainian and Baltic sheets are the largest surface outcrops of the platform. The Ukrainian Sheet stretches from the Sea of Asov to the Sub-Dnestr Highland and South Polesye. Karelia and the Kola Peninsula are on the Baltic crystalline sheet.

Within the Russian Plain, there are gentle highlands – the Valdai, Middle-Russian, Podolian, and Sub-Volga with heights of 200 to 400 m.

The largest lowlands on the Russian Plain – the Pechora, Moscow, Sub-Black Sea, Dnepr, Oka-Don, and Sub-Caspian Sea – are beyond the reach of 100-200 m high, and south half of the Sub-Caspian-Sea lowland has elevations even below sea level.

The Caucasus, a vast mountainous country, is in Southeastern Europe. In the Caucasus, there is the Elbrus Peak, 5642 m. The southern border of the European Continent serves the watershed divide for the Great Caucasus.

The East Europe – Asia border goes along the Ural Mountain Ridge. In its northern part, the height of the ridge is 1894 m (m. Narodnaya). Mountains, ridges, and highlands give birth to many rivers in Europe.

2.2 Climate

Climate of Europe depends on many factors, mainly, total solar radiation and atmospheric circulation. The large meridian length of Europe determins the diversity of total solar radiation values over its territory. During the winter months the values of possible total radiation vary from zero in the north to 350 cal/cm^2 a day in the south. In June, the possible solar radiation all over the continent is above 750 cal/cm^2 a day. Large values of solar radiation in summer in high latitudes are explained by a polar day. However, because of cyclone activity and cloudiness the values of factual solar radiation on the continent are much lower than the potential ones. In North Europe, the factual values of solar radiation are as much as 60-65% of the potential value. Over the territory of Europe with maritime climate, the factual solar radiation varies from 60 to 75% of the potential value. In the Alps, in winter the total solar radiation is 77%, and in summer – only 64% of the potential value. On the Pyrenees Peninsula, under arid climate conditions the observed total solar radiation is close to the potential one under cloudless sky.

European seacoasts are jagged much and most of mountainous regions are located almost along the latitude, which allows humid oceanic air masses to easily penetrate the entire continent.

The atmospheric circulation over Europe shows up as three global oscillations of atmospheric pressure: the North Atlantic, Northern and Southern. In wintertime, an edge of the Siberian anticyclone penetrates Europe. However, in Europe, air masses from Asia are of secondary importance because moisture is transported there mostly by brave west winds. In summertime, there is the west wind drift from the Atlantic Ocean and the north wind drift from the Arctic. In wintertime, humid sea air transport causes precipitation to fall over the temperate climate zone. At this time a dry and cold weather predominates in East Europe.

The total solar radiation changes over Europe and so do the air flow directions because of the effects of the highest mountain ridges, therefore Europe finds itself to be located in two climatic zones – temperate and subtropical.

The northern part of Europe is characterized by a moderate and partially cold climate. Extremely humid maritime climate occurs in Norway, Scotland, Ireland and southern Iceland. The temperate cold continental climate is observed in Sweden, Finland, and northern European Russia.

The sub-Atlantic region of Central Europe is characterized by temperate and temperate-warm climate with humid winters.

East-European climate is temperate-continental: summers are hot and winters are temperate-cold.

In South Europe, the subtropical (Mediterranean) climate predominates with dry hot summers and wet winters.

The territory of Europe is predominently in the zones of successive and sufficient humidification. Exeption is some parts of peninsulas of the Mediterranean and Black Seas as well as the southeastern part of the continent referring to the basins of the Black and Caspian Seas. Annual precipitation in Europe changes from 5000 mm to 150 mm. Annual precipitation up to 5000 mm falls in southwestern Scandinavia as well as on the peaks of western slopes of the Dinara, Caucasus, and Scotland Mountains. In the Alps, annual precipitation is up to 3000 mm.

Considerable part of the continent area is located in arid regions with annual precipitation less than 400 mm. In the Central Pyrenees, East Apennines, steppe Crimea, and Sub-Caspian Lowland, annual precipitation is less than 200 mm.

In the southwest of the British Islands, annual precipitation is up to 2400 mm. On the Hebrides, Scotland, and Orkney Islands, precipitation is more than in the mountainous part of the British Islands.

Eastward, precipitation decreases from 1000 mm (Northwestern France) to 600 mm in the Middle and South Sub-Ural. In the Sudetes, Tatra, and North Carpathian Mountains, precipitation increases up to 1000-1200 mm. From the Polesye to the East all over the Russian Plain, annual precipitation is 600 to 700 mm.

In the Pyrenees and Cantabria Mountains, annual precipitation is up to 2000 mm. In the central Aragon depression, it is as much as 400 mm a year. In the Balkans, annual precipitation is about 1400 mm, locally – up to 1800 mm. In the northern portion of the Adriatic Sea coast, annual precipitation is about 2400 mm. On the vast Hungarian Lowland, annual precipitation is 700 mm.

Within the Sub-Danube Lowland, south of the East-European Plain and Sub-Caspian Lowland, climate becomes more continental from west to east. Therefore, in this direction annual precipitation decreases from 600 mm to 200 mm. Atmospheric precipitation, along with solar radiation, relief, soils, and vegetation, exerts a pronounced effect on the water content of modern rivers.

2.3 Soils and vegetation

Soils and vegetation are spread on the continent in accordance with the latitudinal geographical zonality and altitude belts. The following soil-vegetation zones are typical of Europe: Arctic deserts, tundra and forest-tundra, forest zone including taiga and

mixed broad-leaved forest sub-zones, forest-steppe and steppe, semi-deserts, and evergreen xerophite forest and bushes

Arctic desert is typical of the Arctic Ocean islands. No wood or bush vegetation is there. Lichens, moss, and some other species of phanerogamae that do not form a closing cover predominate in this zone.

Tundra occupies an extreme north of the Russian Plain, Kola and Scandinavian Peninsulas as well as coastal Iceland. Moss, lichens, and dwarf shrubs in this zone. The sites with the tundra thin and clay soils and swamps are spread in northern river valleys. Sub-Arctic meadows are in the northwest of the continent (Iceland and coastal Norway). In the Russian Plain, there is a sub-zone of forest-tundra where tundra vegetation combines with low-stem scrub forest.

The taiga sub-zone occupies a small part of forest zone and stretches southward up to 60^0 N. Taiga consists predominantly of European fir (Picea excelsa) and Siberian fir, silver fir, and larch in the East. Birch (Betula spp,) is also an important component of the taiga. Fir forests grow mostly on clay and argillaceous differences of podzolic and peat-podzolic soils. Pine forests are spread on sand and gravel differences of these soil types and in swampy areas. In the mountains, taiga converts into birch-tree scrub forest that converts into mountain tundra belt at heights of 1000-1200 m in the south and 400-500 m in the north.

The sub-zone of mixed (coniferous and broad-leaved) forests is mainly in Scotland and the South Scandinavian Peninsula. On the German-Poland and Russian Plains, this sub-zone stretches southward approximately up to 53^0 N. In this sub-zone, broad-leaved forests (oak, lime, maple, aspen, hornbeam, and beech) and coniferous (fir and pine) occur. Soils are podzolic and peat-podzolic in the west, and gray forest – in the east.

Southward, there is a sub-zone of broad-leaved forests. Beech and oak forests with lime, hornbeam, and maple are typical of this sub-zone, especially in England, France and Northern Spain. On sands, pine forests occur frequently. In the extreme southwest, chestnut occurs. Brown forest soils are typical of the west, and gray forest – of the east. In limestone areas, there are peat-carbonate soils. In the mountainous regions, particularly in the Alps, broad-leaved forests are spread. The height zonality is very well expressed there: oak forests of piedmonts with admixture of chestnuts convert into beech forests on the lower sites of the slopes. Then, up to about 2000 m, there is a belt of coniferous-broad-leaved and coniferous forests with fir and silver fir, then higher – the bush-meadow sub-Alpine and meadow-Alpine belts.

Forest-steppe covers predominantly the leached out and thick black earth soils. It occupies the continental regions of Europe: the south of the Russian Plain and the Middle-Danube Lowland. In the south, the forest-steppe converts into steppe with predominant diverse forb-gramineous and grass-leaved steppes on ordinary and southern black molds, and in the south of the Ukraine and the Volga River valley, chestnut soils are spread. On the greater part of plains occupying the sub-zones of mixed and broad-leaved forests, forest-steppe and steppe, the natural vegetation is substituted for the cultivated one.

In Europe, the semi-desert zone occupies a small territory in the southeastern part of the Lower Volga River valley. Xerophite bushes and semi-bushes including wormwood and others form a thin cover with some portion of steppe plants such as feather-grass. Brown soils of semi-deserts alternate frequently with solonetz, solonchaks, and sand massifs.

Light evergreen sclerophyll xerophite forests and bushes are the zonal types of vegetation in the Mediterranean Sea zone of the subtropical belt. Different oak species and southern species of pine predominate in the forests. Evergreen bush formations and deciduous xerophite bushes, spread predominantly on the Balkan Peninsula and the southern coast of the Crimea, are mostly the secondary ones that arose on the place of cut-off-forests. On rocky sunny slopes, arid-loving sclerophyll herbs and bushes grow. Usually they do not form a continuous cover. In the southeast of the Pyrenees Peninsula and Sicily, the low-stem but dense bushes of dwarf palm are developed. Under forests and bushes, there are rather fertilized weakly leached out brown soils. Red-color soils develop in the limestone areas. Previously the lower sites of mountain slopes were occupied with forests and bushes at heights up to 600-700 m in the south, and 300-400 m in the north, and small plains in the Mediterranean. Presently, they are mostly cut off and substituted with plantations of citrus, tobacco, olive, grape and fruit orchards, corn and wheat fields.

2.4 Economic activities

Relief, climate, soils, and vegetation are the natural factors of the existence of hydrographic network. During the last three centuries its evolution has been greatly affected by man`s economic activities, in particular, by construction of reservoirs and canals as well as land irrigation. Actually the natural river network has been changed and the man-made one has been created.

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Biographical Sketch

Vladimir Ivanovitch Babkin was born in 1941. In 1965, he graduated from the Voronrzh State University. Since 1969 he has worked at the State Hydrological Institute. In 1970, Babkin defended theses for the degree of candidate of geographical– sciences, and in 1984 – doctor theses of geography.

Since 1982, Babkin is the head of the laboratory «Water Resources and Water Balance» at the State Hydrological Institute, Sanct Petersburg.

V.I. Babkin is the author of 130 scientific papers including seven monographs on hydrology, hydrophysics, and water balance and water resources. Most of his studies deal with hydrological cycle processes (evaporation, runoff, precipitation, and infiltration), developing methods for their estimation, as well as discovering global mechanisms of land moisturizing on the continents.