WATERS

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Slovenia is a country characterized by an abundance of water in a great variety of forms. We usually distinguish between surface and subterranean land waters and the sea. Surface land waters include the river network, lakes, marshes, moors, snowfields, and glaciers while subterranean land waters include groundwater, karst, thermal, and mineral waters.

The river network consists of a multitude of rivers, streams, and brooks totaling almost 27,000 kilometers. The average density of the watercourses in Slovenia is 1.33 kilometers per square kilometer, among the highest density found in Europe. Surface watercourses are not equally distributed because about 40% of Slovenia is karst and therefore almost without surface watercourses. In this regard, some Slovene karst plateaus stand out especially. In contrast to the karst regions, elsewhere the river network is very branched and in places the density of watercourses exceeds three kilometers per square kilometer.

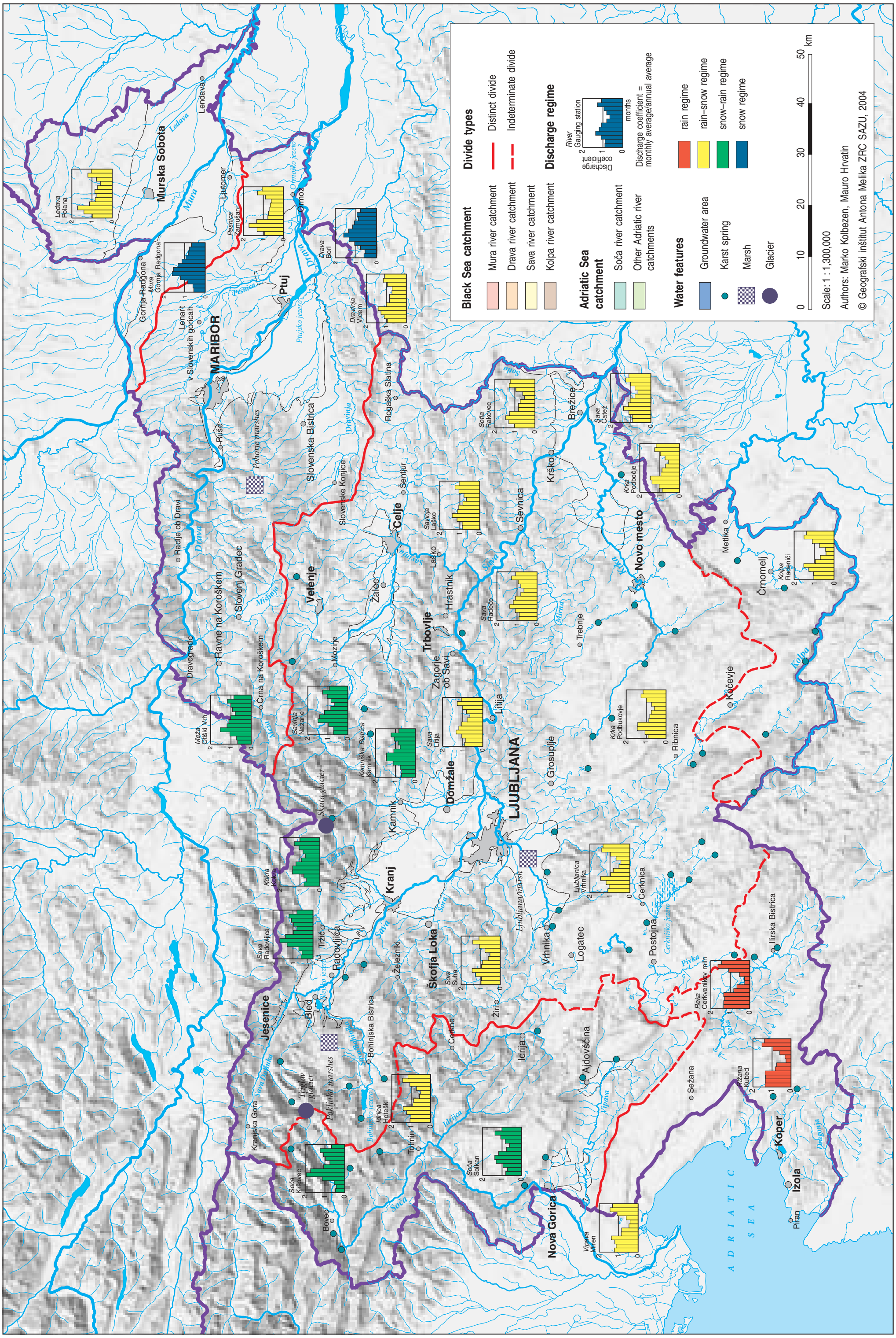
The divide between the Black Sea and the Adriatic Sea runs across Slovenia. Rivers from four fifths of Slovene territory flow several hundred kilometers to the Black Sea and from less than one fifth to the Adriatic Sea. The Black Sea river system comprises the watersheds of the Mura, Drava, Sava, and Kolpa rivers, while the Adriatic river system includes the watersheds of the Soča and Reka rivers and of the small rivers that flow directly to the sea.

Short watercourses are characteristics of Slovenia's water network, and only forty-six rivers are more than twenty-five kilometers long. The longest river is the Sava, which runs 221 kilometers on Slovene territory, followed by the Drava with 142 kilometers and the Kolpa with 118 kilometers. The longest rivers that flow their entire length within Slovene territory are the Savinja (102 km) and the Krka (94 km). The Mura, Soča, Sotla, Ledava, Dravinja, Pesnica, Idrijca, Ščavnica, Reka, and Sora (together with the Poljanska Sora) rivers all have more than fifty kilometers of their length on Slovene territory or along the national borders.

According to the volume of water, the Drava takes first place with an average annual discharge of 322 m^3/s at Dravsko polje. The discharge of the Sava near Čatež (289 m^3/s) is close behind, while the discharge of the Mura near Gornja Radgona (157 m^3/s) is already smaller by half. The Soča, Kolpa, Ljubljanica, and Krka rivers have average annual discharge of more than 50 m^3/s.

In Slovenia, the average annual precipitation is 1,570 mm. Of this, 42% evaporates and the remaining 58% runs off via watercourses. Runoff coefficients indicating the proportion of water flowing into watercourses differ considerably according to the individual regions of Slovenia. The differences are caused primarily by the quantity and the regime of the precipitation and the rock and relief characteristics in the regions. The highest runoff quotients, which exceed 80%, are found in the Upper Posočje region. In most of the country, they range between 40% and 60%. The lowest values are found in Prekmurje where they only rarely exceed 30% (Kolbezen 1998).

According to the average oscillation in the discharge during the year, we distinguish four types of discharge regimes. The snow regime is characteristic of the Drava and Mura rivers, whose watersheds extend into the glaciated and snow-covered high mountains of Hohe and Niedere Tauern in Austria. The single discharge maximum occurs at the transition of the spring into the summer, and the minimum in the winter. The snow-rain regime is characteristic for the alpine Kamniška Bistrica, Tržiška Bistrica, Kokra, Koritnica, Meža, Radovna, and Tolminka rivers and the upper reaches of the Sava, Savinja, and Soča. The primary discharge maximum occurs with the thawing of snow in late spring, and the secondary maximum occurs during the fall rains. The winter discharge minimum is more distinct than the summer one. The rain-snow regime is characteristic of the Dravinja, Idrijca, Kolpa, Krka, Ledava,


Black Sea catchment
Mura river catchment
Drava river catchment
Sava river catchment
Kolpa river catchment
Adriatic Sea catchment
Soča river catchment
Other Adriatic river catchments
Water features
Groundwater area
Karst spring
Marsh
Glacier
Divide types
Distinct divide
Indeterminate divide
Discharge regime
River
Gauging station
Discharge coefficient
months
Discharge coefficient = monthly average/annual average
rain regime
rain–snow regime
snow–rain regime
snow regime
0 10 20 30 40 50 km
Scale: 1 : 1,300,000
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LJUBLJANA
MARIBOR
Murska Sobota
Ptuj
Celje
Velenje
Kranj
Novo mesto
Koper
Izola
Piran
Nova Gorica
Jesenice
Škofja Loka
Domžale
Kamnik
Trbovlje
Postojna
Kočevje
Črnomelj
Krško
Brežice
ADRIATIC SEA

◄ *Figure 1: Inland waters.*

Ljubljanica, Mirna, Pesnica, Sora, Sotla, Ščavnica, and Vipava rivers and in the lower stretches of the Sava, Savinja, and Soča. The spring snow discharge maximum always exceeds the fall rain maximum, but the summer discharges are substantially lower than those in winter. The rain regime is characteristic for the Pivka, Reka, and Rižana rivers in southwestern Slovenia. Above-average discharges occur here in the colder half of the year from November to April, while in late spring and summer the discharges are modest due to high temperatures and strong evapotranspiration (Hrvatin 1998).

With heavier and longer rains, floods occur along numerous watercourses, threatening about 500 km^2 of land. The largest flood areas are on the Ljubljansko Barje moor (80 km^2) and along the Dravinja (66.5 km^2) and Krka (62 km^2) rivers. Flood areas larger than 20 km^2 are also found along the lower stretches of the Savinja and Sava, along the Sotla and Kolpa, and on Cerkniško polje.

Floods can be regular, occurring according to the river regime at specific times of the year, and have an anticipated spread, for example, the annual floods along the Krka River, on the Ljubljansko Barje moor, and on Planinsko polje. Extraordinary floods occur at unusual times of the year and have an exceptional spread or impact. Destructive floods struck the river basins of the Idrijca, Sora, Kamniška Bistrica, Savinja, Meža, Dravinja, Pesnica, Ščavnica, and Sava rivers in 1990. To protect the land from floods and erosion, extensive regulation work has been undertaken in Slovenia for more than a hundred years (Orožen Adamič 1998).

In the past, the power of rivers was harnessed by more than 4,000 water-driven flourmills and sawmills, but most of these were abandoned in the 20th century. They were replaced by hydroelectric power plants that produce more than one third of Slovenia's electric energy supply. River water is also used for cooling in thermoelectric power plants and the nuclear power plant in Krško, as technological water in industry, and for irrigation. Due to the pollution of the river water, it can no longer be used directly for the supply of drinking water (Bat and Uhan 1997).

Natural lakes in Slovenia are rare and small, and are divided into glacial and karst lakes. The largest and best-known glacial lakes are Lake Bohinj and Lake Bled. Lake Bohinj measures 3.18 km^2 and has a maximum depth of 44.5 meters. It is a discharge type, so its water is quickly renewed. Lake Bled, with a surface area of 1.40 km^2 and a maximum depth of 30.6 meters, is somewhat smaller. In the high mountains of the Julian Alps, there are several smaller glacial lakes, among which the Triglav lakes, Kriška lakes, and Krn lakes are best known.

The disappearing Cerknica Lake measures 21 km^2 during normal flooding, and with exceptionally high waters its surface area exceeds 28 km^2. On average, it lasts for almost ten months of the year. It usually fills up during the fall rains and disappears only in the summer months of the following year. Only a few karst lakes never disappear. One such lake is Jezero near Podpeč below Mount Krim, which is Slovenia's deepest lake with a depth of 47 meters.

Artificial lakes include reservoirs beside hydroelectric power plants, multi-purpose water reservoirs, and lakes that developed in depressions above abandoned mines.

Marshes are areas where the ground is waterlogged. In recent decades, their surface area has been rapidly shrinking due to intensive drainage. Larger hydromeliorations of marshy areas were carried out along the Ledava, Mirna, Mura, Pesnica, Polskava, Ščavnica, and Vipava rivers and along the lower course of the Krka River. In 1990, marshes together with fishponds and reed ponds occupied only 2,200 hectares.

A moor is a special kind of marshland with vegetation whose dead remains are deposited as peat. One well-known moor is Zelenci near the source of the Sava River, while the once much larger Ljubljansko Barje moor was destroyed to a great extent by the cutting of peat.

Snowfields and glaciers are an important and simultaneously very changeable element of the high-mountain areas. Comparisons between various historical sources and the current situation show that the number and size of formerly frequent and large mountain snowfields are decreasing. The glaciers on Mount Triglav and below Mount Skuta have also been rapidly shrinking in recent decades. The Triglav glacier, which covered almost 46 hectares in the 1880's, has dwindled today to a mere 1.4 hectares.

Subterranean waters, which include groundwater, karst, thermal, and mineral waters, greatly surpass surface waters in quantity. The sites of groundwater are basins and river valleys with thick deposits of Tertiary and Quaternary gravel and sand alluvia. The most important sites are the Apače, Mura, and Ljutomer poljes in the Mura watershed; the Dravsko-Ptujsko polje in the Drava watershed; the Ljubljana, Kranj-Sora, and Krško-Brežice poljes and the Kamniška Bistrica and Lower Savinja valleys in the Sava watershed; and the Vipava Valley and the Soča polje in the Soča watershed (Kolbezen 1998).

At the moment, groundwater supplies more than half of Slovenia's drinking water. Because the basins are very densely populated, crisscrossed by traffic arteries, and intensively cultivated and at the same time polluted rivers are directly linked to the groundwater, there is a great and constant threat of pollution hanging over this important natural resource, either directly from the surface or indirectly from the rivers. The pollution of the groundwater could prohibit its use in the public water supply for years or even decades. The greatest threat of groundwater pollution occurs during droughts because the dropping level of the water table allows the penetration of polluted river water into the gravel and sand (Natek and Natek 1998).

Karst waters feed the springs of the Soča, Sava, Idrijca, Vipava, Ljubljanica, Krka, and Kolpa rivers and many of their tributaries. Some karst springs such as the Rižana, Malenščica, Podroteja, and Mrzlek springs are vital for the water supply of entire areas. During droughts, they represent three quarters of all the available water supplies.

Thermal and mineral waters are special types of subterranean water. So far, twenty-four natural thermal and thermo-mineral springs with temperatures between 18° C and 38° C have been discovered. Thermal waters are exploited mainly by the health resorts at Čatež, Dolenjske Toplice, Šmarješke Toplice, Podčetrtek, Ptuj, Rimske Toplice, Topolšica, and Zreče. The most important locations of mineral water are in porous Tertiary sand and gravel (Radenci) and in tectonically fissured rock (Rogaška Slatina). In the western part of Pomurje, there are extensive sites of thermo-mineral water containing dissolved CO_2 at depths between 700 and 1,300 meters.

In addition to land waters, a small part of the Adriatic Sea including part of the Bay of Trieste and forty-seven kilometers of coastline belongs to Slovenia. While the Slovene share of sea surface is insignificant, the economic and geopolitical importance of the sea is incomparably greater. The Slovene sea is very shallow and only rarely exceeds the depth of twenty meters. It is deepest in the undersea basin off Piran, where it is thirty-seven meters deep. The average annual temperature of the sea is 15.8° C, the lowest is 8.1° C in February, and the highest is 24.0° C in August. Due to the abundant influx of fresh water, its average saltiness is lower than the Adriatic average and oscillates between 33‰ and 38‰. The currents are weak, and the amplitude between the mean low tide and mean high tide is only sixty-six centimeters on average (Bat and Uhan 1997).

Due to its small size and closed character, the Bay of Trieste ranks among the most polluted parts of the Adriatic Sea. About 400,000 people live along the shoreline, and communal waste is joined by the waste generated by industry, maritime traffic, tourism, and, to a lesser degree, agriculture. A large influx of organic and inorganic material comes also from the Po River (Natek and Natek 1998).

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