Physicogeographical Characteristics of the Republic of Adygea

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Abstract The chapter presents the physical and geographical conditions of the Republic of Adygea. Brief information is given on the relief, climate, water, geothermal, land, forest, and mineral resources. Specially protected natural areas, as well as the main species of flora and fauna, are listed. Particular attention is paid to the recreational resources of the Republic, which have great potential. The main problems of environmental pollution are discussed, which, on the one hand, are a consequence of the development of industry and agriculture and, on the other hand, can affect the development of tourism in the Republic.

Keywords Climate, Environmental issues, Natural resources, Physical and geographical conditions, Republic of Adygea, Specially protected natural areas, Topography, Tourism

1 Introduction

The Republic of Adygea is a region of the Russian Federation located in the central part of the Northwest Caucasus. The Republic belongs to the Southern Federal District. The territory of the Republic is surrounded on all sides by the territory of Krasnodar Krai (Fig. 1). The territory of Adygea occupies the central part of the plain between the Laba River and Afips River and a part of the northern slope of the Greater Caucasus, located in the Belaya River Basin. In the north and northeast, the territory of the Republic is limited by the Kuban River and its tributary, the Laba River, and in the south by the Greater Caucasus Ridge. The area of the Republic is 7,790 km^2. The length of its territory from north to south is 208 km (from 45°13′ to 43°46′ N) and from west to east 165 km (from 38°41′ to 40°6′ E). The length of the borders is more than 900 km; one third passes through water bodies, along the Kuban River, the Krasnodar Reservoir, the Laba River, and the Belaya River [1, 2].

In this chapter, we briefly present the physical and geographical conditions of the Republic of Adygea: relief, climate, water, geothermal, land, forest, and mineral resources. We provide information on specially protected natural areas, as well as on the main species of flora and fauna. Particular attention is paid to the recreational resources of the Republic, which have great potential. The main problems of environmental pollution are discussed, which, on the one hand, are a consequence of the development of industry and agriculture and, on the other hand, can affect the development of tourism in the Republic.

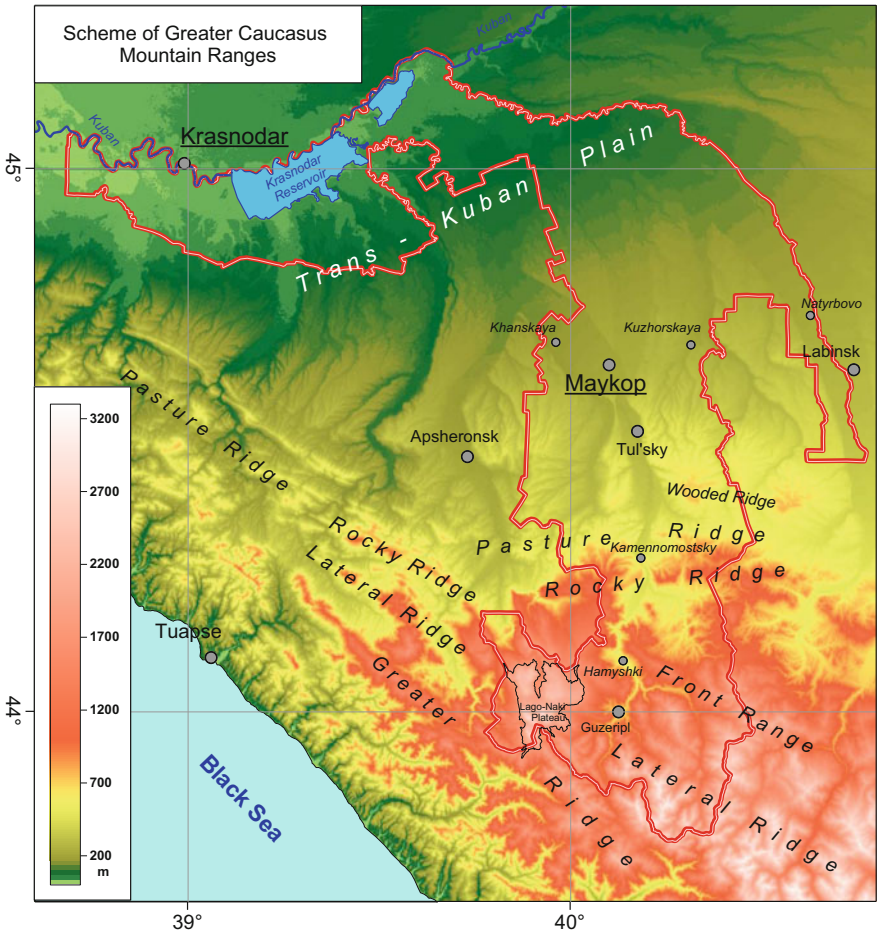


Fig. 1 The scheme of the Greater Caucasus Mountain Ranges on the territory of the Republic of Adygea delimited by a red line

2 Relief

The Republic of Adygea is located on the plains, in the foothills, and in the mountains of the Greater Caucasus. By the relief, Adygea can be divided into three parts: (1) flat, from the latitudinal course of the Kuban River up to the latitude of Khanskaya Stanitsa (a village inside a Cossack host) to Kuzhorskaya Stanitsa to Natyrbovo Village; (2) piedmont, up to the latitude of Kamennomostsky (old name Khadzhokh) Village (up to the Rocky Ridge); and (3) mountainous, to the southern borders of the Republic [1–3] (Fig. 1).

The southern part of the Azov-Kuban Plain is called Trans-Kuban Plain, and it is located in a piedmont subsidence and is a lowland that gradually passes into a

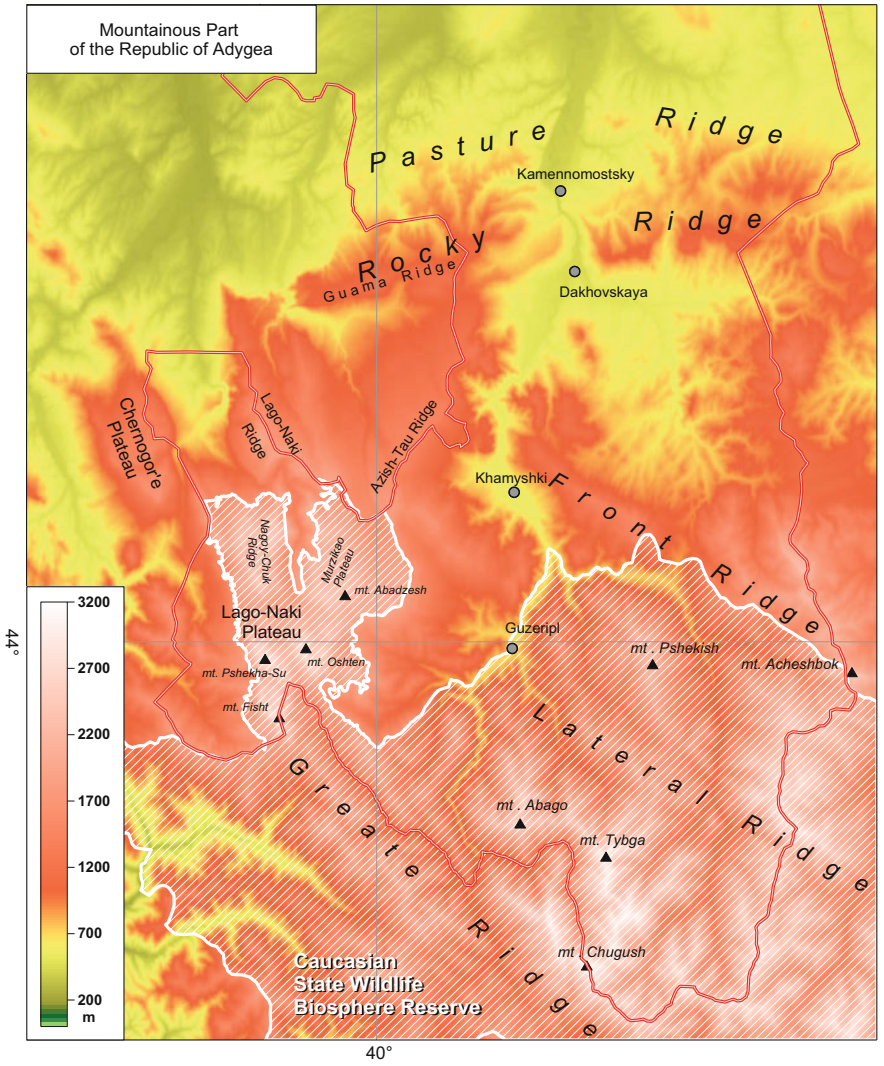


Fig. 2 The mountain part of the Republic of Adygea [5] (with permission from Ecologica Montenegrina)

piedmont high plain. The piedmont zone extends from the Maykop City, lying at an altitude of 230 m above the sea level, up to about Kamennomostsky Village. There are low (up to 300–500 m) sloping ridges, dissected by wide river valleys. Some peaks reach up to 700–900 m (Fig. 1) [1].

The mountainous part of the Republic of Adygea is presented by the system of the Greater, the Front, the Lateral, and the Rocky Ridges of the Greater Caucasus (Figs. 1 and 2). The Skalisty (Rocky) Ridge has a characteristic sharply asymmetric appearance throughout. Its northern slope is gentle and long, while the southern

slope is steep and short. The top of the ridge is composed of limestones and dolomites, while the lower part is shale clay and sandstone. In its relief, mid-mountain and low-mountain structures are represented, and the following karst forms are widespread: funnels, caves, wells, and mines. The most famous Shidekh Mountain (1,105 m) is located near the village of Dakhovskaya (Dakhovskaya Stanitsa) [4].

The Front Range is located to the north of the Greater Caucasus Range and stretches in the southeastern direction outside Adygea. The width of the Front Range varies between 5 and 15 km. Its length is more than 100 km. At the same time, it has soft and flat topography. The highest point of the Front Range within the Republic of Adygea is Acheshboki Mountain (2,486 m) [1].

Between the Greater Caucasus Ridge and the Front Ridge lies the Lateral Ridge. On the territory of Adygea, it has Pshekish Mountain (2,242 m) and Abago Mountains (2,689 m), which are located in the Caucasus State Wildlife Biosphere Reserve (Fig. 2) [4, 5].

South of Maykop City is the low-mountain Wooded Ridge. The maximum height of the Wooded Ridge in Adygea is 683 m, the most famous being Shakhan Mountain [1].

The Pastur Ridge, located south of the Wooded Ridge and north of the Rocky (Skalisty) Ridge, is a low mountain composed of limestones, schists, and sandstones of the Cretaceous period, with more steep southern and more gentle northern slopes. The significant peak of the Pastur Ridge is Fiziabgo Mountain (992 m) near the village of Pobeda. The relief of the foothills enhances the spatial differentiation of microclimatic conditions [4].

The Greater Caucasian Ridge restricts the territory of the Republic from the south and consists of a system of echelon ridges with different absolute altitudes of 3–25 km in width. The main peaks of the Greater Caucasian Ridge within Adygea are Chugush Mountain (3,238 m) (Fig. 3) and Tybga Mountain (3,064 m) (Fig. 4). These are the highest mountains of the Republic of Adygea; they lie on the territory of the Caucasian State Wildlife Biosphere Reserve [4, 5].

Lago-Naki Plateau (Fig. 5) with the average height of 2,000 m occupies the most part of the mountains of Adygea (Fig. 2). It stretches from the north to the south and from the west to the east for more than 40–45 km and includes the Murzikao Ridge, which comprises Abadzesh Mountain (2,287 m), Kamennoye More (Stone Sea) Ridge, and Nagoy-Chuk Ridge. The mountain group of Fisht Mountain (2,867 m) is a center of the mountainous part of Lago-Naki Plateau which is a part of the Greater Caucasus Range. In the west, Fisht Mountain joins the Pshekha-Su Mountain mass (2,743 m). To the north of Pshekha-Su Mountain, there is the Oshten Mountain mass (2,804 m) (Fig. 6). Major orographic elements located outside the plateau are Lago-Naki Ridge, Azish-Tau Ridge, and Chernogor'e (Black Mountain) Plateau [1, 5].

On the Lago-Naki Plateau, 125 karst mines and caves are known [4]. Of these, the deepest cave in Russia, the "Soaring Bird" Cave, is located on the southern array of Fisht Mountain. The total length of the cave is 1,290 m, depth 535 m, area 800 m^2, and volume 16,000 m^3. The entrance to the cave is located at an altitude of 2,350 m.

Fig. 3 Mountain Chugush (photo by S.A. Trepet)

Fig. 4 Mountain Tybga (photo by S.A. Trepet)

Fig. 5 Lago-Naki Plateau (photo by S.A. Trepet)

Fig. 6 Fisht-Oshten Mountain Range (photo by S.A. Trepet)

Fig. 7 Bolshaya (Big) Azishskaya Cave (photo by S.A. Trepet)

On the Azish-Tau Ridge, two karst caves, Bolshaya (Big) Azishskaya Cave (Fig. 7) and Nezhnaya (Tender) Cave, are located. The entrance to the Bolshaya (Big) Azishskaya Cave is located at an altitude of 1,520 m. It has a length of 690 m

and a volume of more than 11,000 m^3. In 1987, 220 m of the cave were equipped for sightseeing. The entrance to the Nezhnaya (Tender) Cave is located on the eastern slope of the Azish-Tau Ridge, near the headwaters of the Mezmay River, at an altitude of 1,400 m above sea level. The dimensions of the cave cavity are as follows: length, 95 m; depth. 7 m; and volume, 530 m^3. For visitors, the cave became available only in 1998 [4].

3 Climate

The climate in the Republic of Adygea is diverse: in the northern lowland part, it is moderately continental; in the foothills, it is moderately warm humid; and in the mountains, it has a cold climate of high mountains [6]. The total solar radiation entering the territory of the Republic is 4,830–4,914 kJ/cm^2 (Fig. 8a). The duration of sunshine reaches 2,200–2,400 h/year. The warm period lasts 9–10 months. A combination of excess heat with a relative lack of moisture is characteristic of the lowland and foothill parts, and in the mountainous part, humidification is excessive. The average air temperature in the plain varies from +24.5°C in summer to −2.4°C in winter and in the mountains from +14°C in summer to −3.8°C in winter (Fig. 8b, c). The average annual rainfall on the plain is 650 mm and in the mountains 1,200 mm (Fig. 8d) [6].

In Maykop City, the climate is mild and humid. The average January temperature is −1.6°C and in July +22.2°C. Precipitation is about 700 mm per year (the largest amount is from April to November). The frost-free period is 180 days [1].

Mountains are a barrier protecting the northern part of the Republic from the Black Sea and significantly weakening its influence. The central and northwestern parts of the Republic are separated from the Black Sea by low mountain ranges; therefore, the influence of the sea is more pronounced in them. The system of ranges prevents the penetration of air masses from the east from the Central Caucasus into the mountain zone of the Republic, while the influence of air masses moving from the north is somewhat enhanced due to their stationation in front of the Greater Caucasus Ridge and exacerbation of fronts. Cold air masses flow into the plains of the Republic from the northeast, in particular, through the Armavir Corridor – the lowered space between the Stavropol Upland and the mountains of the Greater Caucasus [1, 6].

4 Water Resources

The Republic of Adygea has large reserves of water resources, which are composed of rivers, lakes, reservoirs, glaciers, and groundwater. The hydrological conditions of the Republic are determined by the features of its relief, geological structure, and climate.

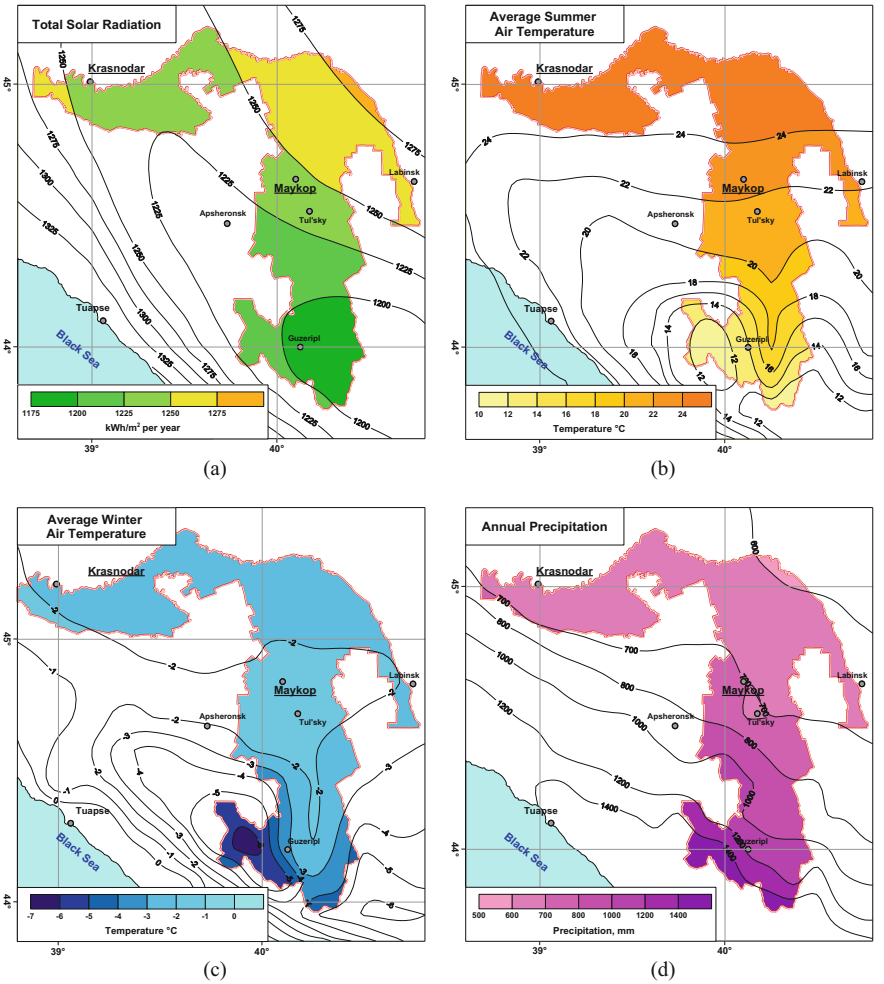


Fig. 8 Distribution of total solar radiation (kWh/m^2 per year) (**a**), average summer air temperature (°C) (**b**), average winter air temperature (°C) (**c**), and annual precipitation (mm) (**d**) on the territory of the Republic of Adygea based on data from [2, 7]

The hydrographic network of the Republic of Adygea (Fig. 9) belongs to the basin of the Sea of Azov. The average total annual runoff of Adygea rivers is about 10 km^3 [1]. The main rivers of Adygea are Laba River, Belaya River, Pshish River, Fars River, Psekups River, Pshekha River, Pshekhashkha River, and Kurdzhips River – all of them are left tributaries of the Kuban River and belong to the class of medium rivers (Table 1). Some rivers of the foothills and the Kuban River in the lower reaches form floodplains, occupying about 30,000 ha (out of 70,000 ha of floodplain lands). The Republic's territory is crossed by 150 medium and small

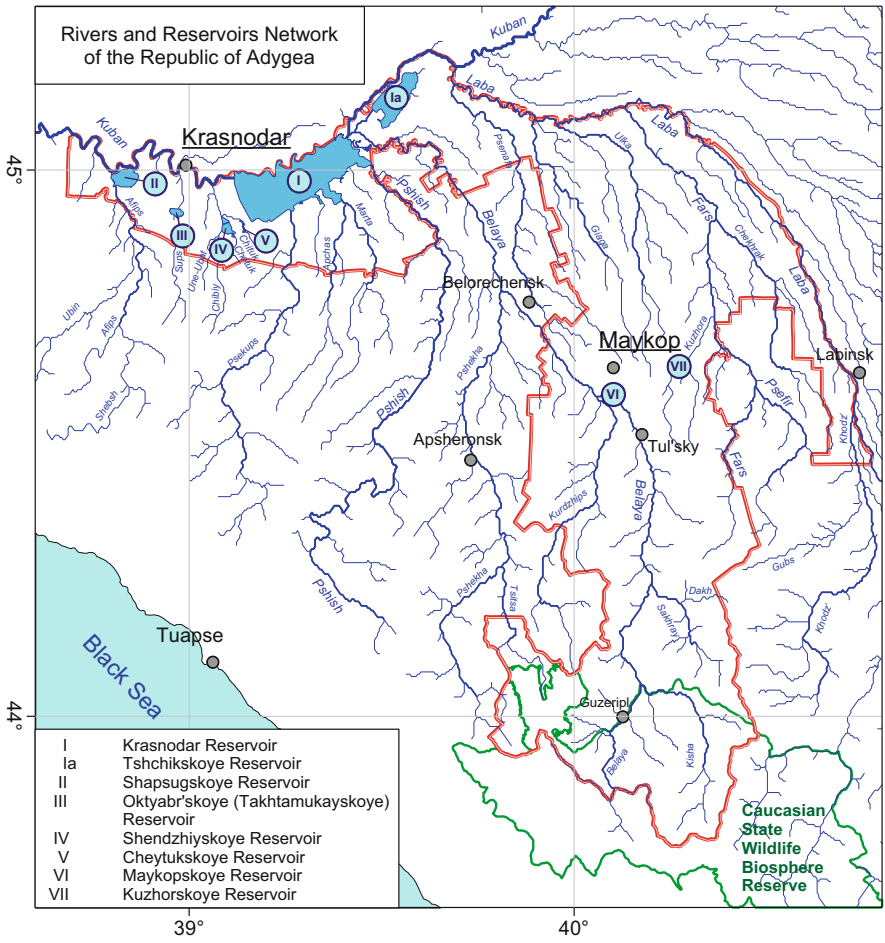


Fig. 9 Map of the hydrographical network and main water reservoirs of the Republic of Adygea

Table 1 Hydrological characteristics of main rivers [1, 2]

River	Watershed area, km^2	Length, km
Kuban	57,900	941
Laba	12,500	341
Belaya	5,990	277
Pshish	1,850	258
Fars	1,450	197
Psekups	1,430	146
Pshekha	2,090	139
Kurdzhips	780	108

Table 2 Morphometric characteristics of the main reservoirs of the Republic of Adygea [1, 2, 8]

Reservoir	Morphometric characteristics					Year of construction
	Volume, m^3	Surface, km^2	Length, km	Width, km	Mean depth, m	
Krasnodar (including Tschikskoye)	2,350	400	46.0	9.0	12.0	1973
Tschikskoye (separately)	232	76	16.0	5.0	1.0	
Shapsugskoye	130	46	9.0	8.0	3.5	1952
Shendzhiyskoye	22	7.8	4.0	3.6	4.0	1965
Oktyabr'skoye (Takhtamukayskoye)	15	9.4	4.0	3.0	2.5	1964
Kuzhorskoye	2.1	0.5	1.3	2.2	2.1	1965
Cheytukskoye	1.5	1.5	2.6	2.5	2.1	1955
Maykopskoye	0.8	0.5	0.5	0.4	5.0	1950

rivers flowing down from the Greater Caucasus Ridge and its spurs, 95% of which belong to small streams. The total length of the river network is 9,482 km [1].

Mountain rivers are characterized by high water velocities, lack of ice formation in winter, and low water temperatures in summer. In the central and northern parts of the Republic, rivers are characterized by high turbidity of the waters, which complicates their drinking water use.

Most of the rivers of the Republic are fed by atmospheric precipitation by 90%. For Kuban River, Laba River, and Belaya River, the sources of which are located on the Greater Caucasus Ridge, high-altitude snow and glacier feeding is important.

There are also more than 100 small lakes, 294 ponds, and 7 water reservoirs that have been created in Adygea to regulate the flow of the Kuban River: Krasnodar Reservoir, Shapsugskoye Reservoir, Shendzhiyskoye Reservoir, Oktyabr'skoye (Takhtamukayskoye) Reservoir, Kuzhorskoye Reservoir, Cheytukskoye Reservoir, and Maykopskoye Reservoir (Table 2) [1, 2, 8].

Lakes of Adygea are small: on the plains, the lakes are floodplain lakes and in the mountain tectonic, glacial-karst, and karst-suffosion lakes. Lakes of karst and glacial genesis are mainly concentrated on the territory of the Caucasian State Wildlife Biosphere Reserve. They are small (0.1–0.3 km^2), the depths vary significantly, and the water is fresh and clear.

On the Lago-Naki Plateau, karst and glacial-karst lakes are common. The largest glacial-karst lake is Lake Khuko (Fig. 10), located between the Pshekhashkha River and the Shakhe River at an altitude of 1,744 m. "Khuko" in Adyghe language means dolphin. This is due to the fact that from the top of the nearby mountain of the same name, the shape of the lake resembles the shape of a dolphin. The lake has an oval shape and stretches from the southeast to northwest. The banks of the lake are slightly indented. The height of the slopes surrounding the lake ranges from 5 to 100 m. The area of the lake is 27,500 m^2 with a length of 260 m and a width of 150 m. Its maximum depth is 10 m. There are no rivers that inflow or outflow the lake, but the water level in it is constant throughout the year [4].

Fig. 10 Lake Khuko (photo by S.A. Trepet)

The mountain rivers of Adygea are characterized by significant hydropower resources. Currently, the hydropower resources of the Belaya River are used by the Maykop hydroelectric station. The capacity of the hydroelectric power station is 9.4 MW, and the average annual output is 48.4 million kWh [1].

Groundwater plays a significant role in the water balance. The territory of the Republic of Adygea belongs to two artesian basins: the groundwater basin of the Greater Caucasus and the Azov-Kuban Artesian Basin (in the northern part of the Republic). The total water withdrawal from underground sources in the Republic exceeds 50 million m^3 per year [1].

5 Mineral Resources

The territory of the Republic of Adygea is rich in the following types of mineral raw materials [1]:

1. Fuel and energy resources represented by hydrocarbon raw materials (natural gas, oil, and gas condensate). Two oil and gas condensate fields are currently in operation: Maykopskoye and Koshekhablskoye.
2. Ore minerals are represented by manifestations of nonferrous, ferrous, and noble metals with insignificant resources. These are manifestations of ore mineralization of molybdenum, tungsten, polymetals (lead, zinc, copper), and manganese ores of carbonate and oxidized types.

3. Nonmetallic minerals occupy the largest share (about 70%) and are represented by a wide variety of species:
   - Industrial and mining raw materials (ceramic, brick, tiled, expanded clay, technological limestones for the sugar industry, gypsum for various purposes, glauconitic sandstones, phosphorites, zeolites, barite, quartz sand, and dolomites for the glass industry).
   - Building materials (building gypsum, building sands, boulder-gravel-sand mixtures, building limestones).
   - Facing and decorative and ornamental stones (red-colored, marbled, and dolomitic limestones, dolomites, gypsum and anhydrites, sandstones, granites, amphibolites, serpentinites, listvinites).
4. Mineral waters of various purposes and composition, healing clay.
5. Fresh groundwater for drinking and industrial purposes and industrial bottling.

In the structure of the mineral resource base, the largest share of explored reserves is accounted for by nonmetallic minerals, which makes it possible to extract raw materials for the production of various building materials. The presence of mineral water reserves and healing clays allows to develop the direction of spa and sanatorium recovery and treatment.

6 Geothermal Resources

The values of heat flows from the Earth's interior in the Republic of Adygea range from 40 to 85 mW/m^2. In the large central part of the territory, which belongs to the platform part of the West North Caucasus Region, these values reach 60–85 mW/m^2. Only in the western part of the Republic, which is located within the East Kuban Depression, the values decrease to their minimum [7, 9, 10].

Increased values of deep heat flows induced by the specifics of the geological structure and development of the Republic of Adygea, combined with changes in the capacities of lithologic-stratigraphic complexes of different thermal conductivities, predetermined the high-temperature character of the subsurface of this territory. The temperature at a depth of 1,000 m varies from 40 to 60°C; at 2,000 m, from 70 to 100°C (Fig. 11); at 3,000 m, from 100 to 140°C; and at 5,000 m, from 140 to 175°C. On the West Kuban Trough territory and in the western regions of the Republic, there is a temperature decrease of 20–40°C in comparison with the central part of Adygea [7].

The deposits discovered so far and the manifestations of thermal waters in the drilled areas indicate that according to the most conservative estimates, almost 50% of the territory of the Republic of Adygea is promising for thermal waters. Hot water here, as a rule, is obtained by spontaneous flow and with a sufficient flow rate for practical use. Thus, the presence of geothermal resources in the territory allows creating and developing alternative energy facilities in the Republic.

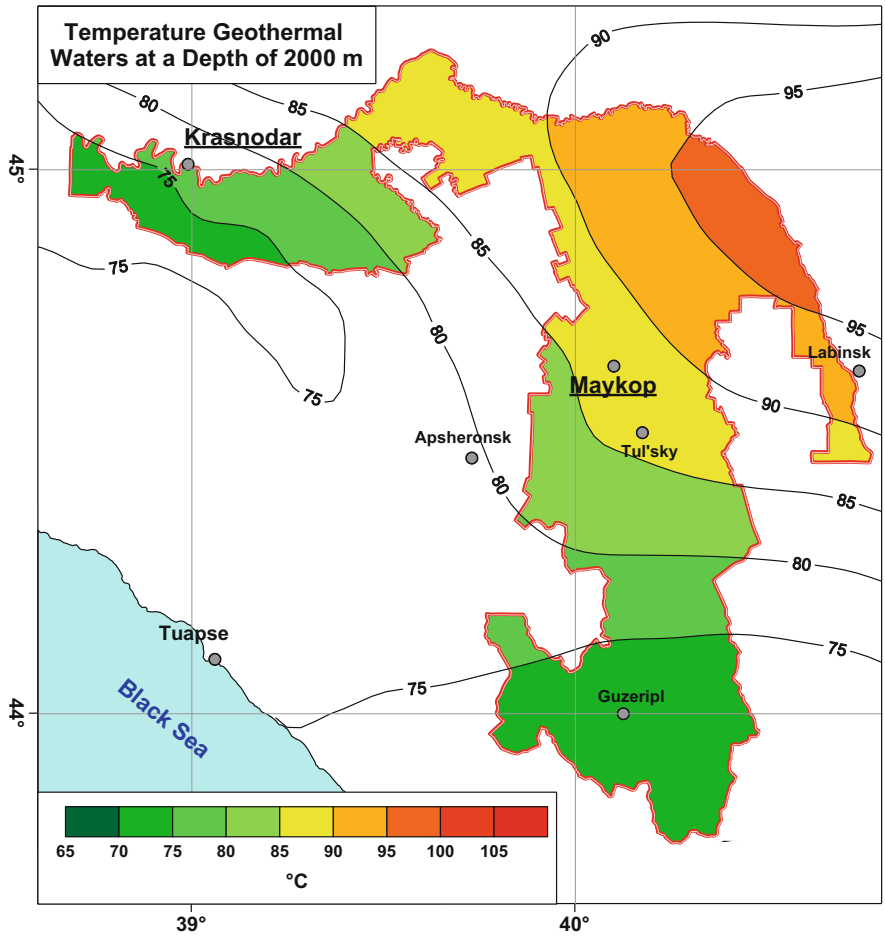


Fig. 11 Distribution of temperature of geothermal water (°C) at a depth of 2,000 m in the Republic of Adygea [10]

7 Land Resources

Most of the territory of the Republic of Adygea is occupied by agricultural land (42.8%) and forest land (30.6%). The lands of specially protected territories and objects account for 11.9%; the lands of settlements 6.2%; the lands of industry, transport, communications, and other nonagricultural purposes 2.1%; the lands of the water fund 6.2%; and the lands of stock 0.2% of the land fund of the Republic of Adygea (Table 3) (Fig. 12) [11].

In all municipalities of the Republic of Adygea, except for the Maykop District, agricultural lands prevail. More than 80% of agricultural land is located in the Giaginsky District (89.1%), the Shovgenovsky District (84.7%), and the

Table 3 Distribution of land between municipalities of the Republic of Adygea (ha) [11]

Municipality	Total area of lands	Agricultural lands	Lands of settlements	Lands of industry, transport, and other purposes	Lands of specially protected areas	Forest lands	Lands of water fund	Lands of stock
Giaginsky District	79,530	70,751	5,732	1,289	10	1,221	116	411
Koshekhablsky District	60,596	49,396	4,301	621	0	5,002	1,229	47
Krasnogvardeysky District	72,552	44,630	4,450	911	0	3,984	18,245	332
Maykopsky District	366,743	43,612	8,149	8,085	92,872	212,798	797	430
Takhtamukaysky District	46,360	25,372	8,827	1,528	1	2,581	8,015	36
Teuchezhsky District	69,797	39,609	3,387	1,778	37	5,702	18,966	318
Shovgenovsky District	52,143	44,173	3,512	273	0	3,568	617	0
Maykop City	28,220	14,130	8,708	1,197	0	3,745	186	254
Adygeysk Town	3,239	1,763	1,022	394	0	51	9	0
Republic of Adygea	779,180	333,436	48,088	16,076	92,920	238,652	48,180	1,828

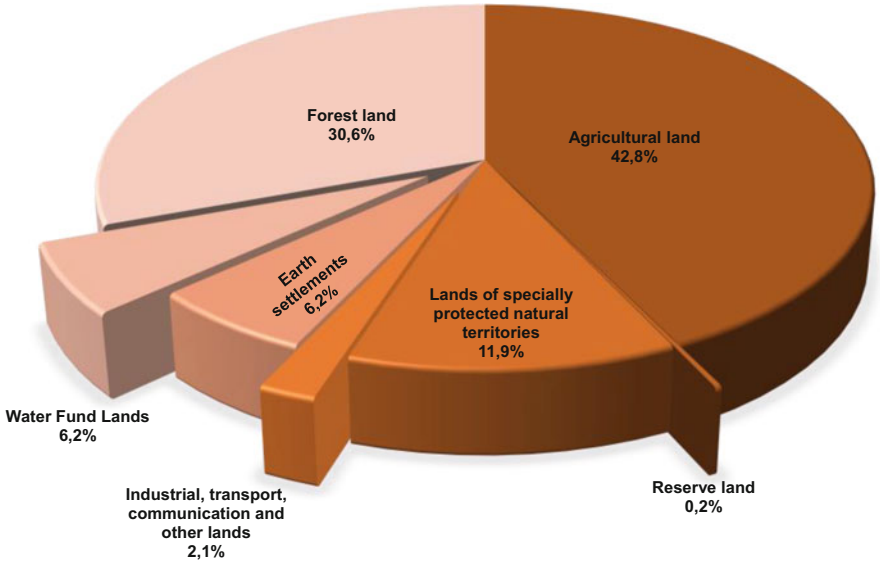


Fig. 12 Distribution of the Republic of Adygea land fund by categories as of January 2017 (based on data [11])

Table 4 Territorial zoning of lands of the Republic of Adygea according to their suitability for use in agriculture [11]

Zone	Territorial zones of the Republic	Grain equivalent value	Area, ha
1	"Especially valuable"	>57	54,769
2	"Medium and above average"	44–57	210,289
3	"Below the average"	31–44	211,589
4	"Low productive"	<31	240,903
5	"Unproductive"	0	7,144
6	Under water	–	48,184

Koshekhablsky District (81.8%). Maykopsky District, which occupies 47.1% of the Republic's territory, is dominated by forest land (57.7%) and special purpose land (25.0%) (Table 4).

The territory of the Republic is very different in climatic conditions, which affect their suitability for use in agriculture. This was reflected in the land valuation and zoning of agricultural lands by differentiation according to the grain equivalent [12], taking into account the values of which six zones were identified in the Republic of Adygea (Table 4) (Fig. 13) [11].

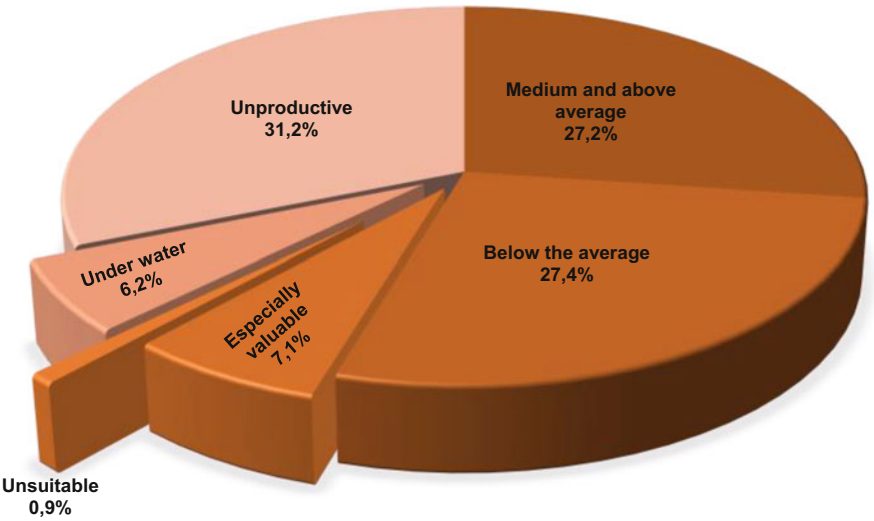


Fig. 13 Distribution of agricultural lands of the Republic of Adygea by zones as of January 2017 (based on data [11])

8 Forest Resources

Forests occupy 285,700 ha, which is 36.6% of the total area of the Republic, respectively. Most of the forests are concentrated in the foothills and mountains (Fig. 14). The main forest-forming species are beech and oak [1]. Eastern beech is one of the most common tree species in Adygea at altitudes of 700–1,000 m and at altitudes of 1,000–1,500 m in combination with fir.

Mountain and foothill oak forests of Adygea are widespread at heights of 300–700 m. In the crossed mountainous regions, these forests play an important water conservation and soil-protective role. In oak stands, main felling is carried out [13].

Of great value are wild-growing forests, chestnut, and walnut stands that occupy small areas [14]. The wild forests of Adygea are a unique natural phenomenon. Their area is over 15,000 ha.

In the northern lowland zone, forested areas occupy a total of about 20,000 ha. The areas of forests here are insignificant, and forest shelter belts and splits are more common, which are scattered among the fields, often confined to river valleys, ponds, and low places. Oak, ash, hornbeam, maple, poplar, willow, and alder grow in the plantings. Forest-steppe plantations of Adygea have a large water protection and sanitary hygienic purpose [15].

Of the total forest area of the Republic, 171,100 ha (61.4% of the forested area) are concentrated on the lands of the forest fund, 59,700 ha on the lands of nature conservation and recreation, and 41,800 ha on the lands of agricultural enterprises. The total forest reserves of Adygea are estimated at 50 million m^3 [1, 13, 15].

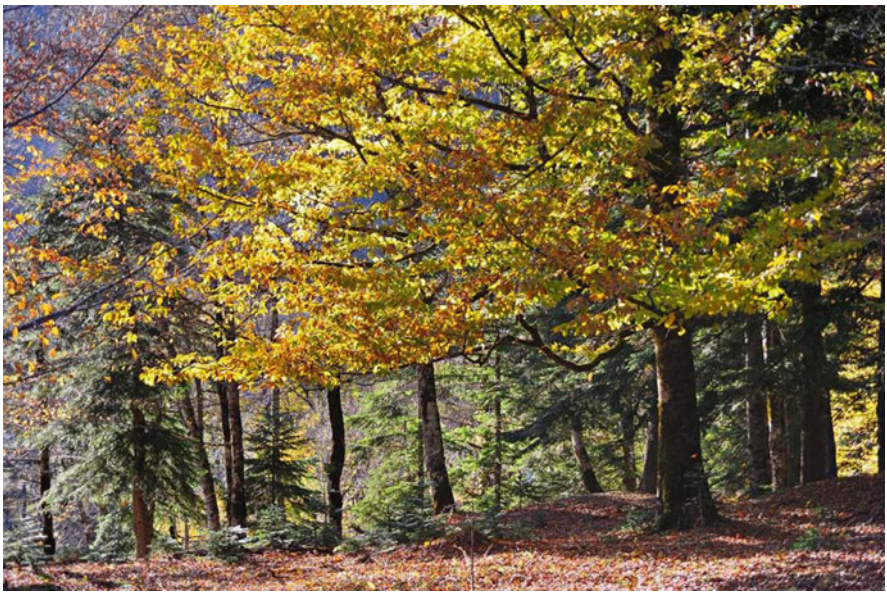


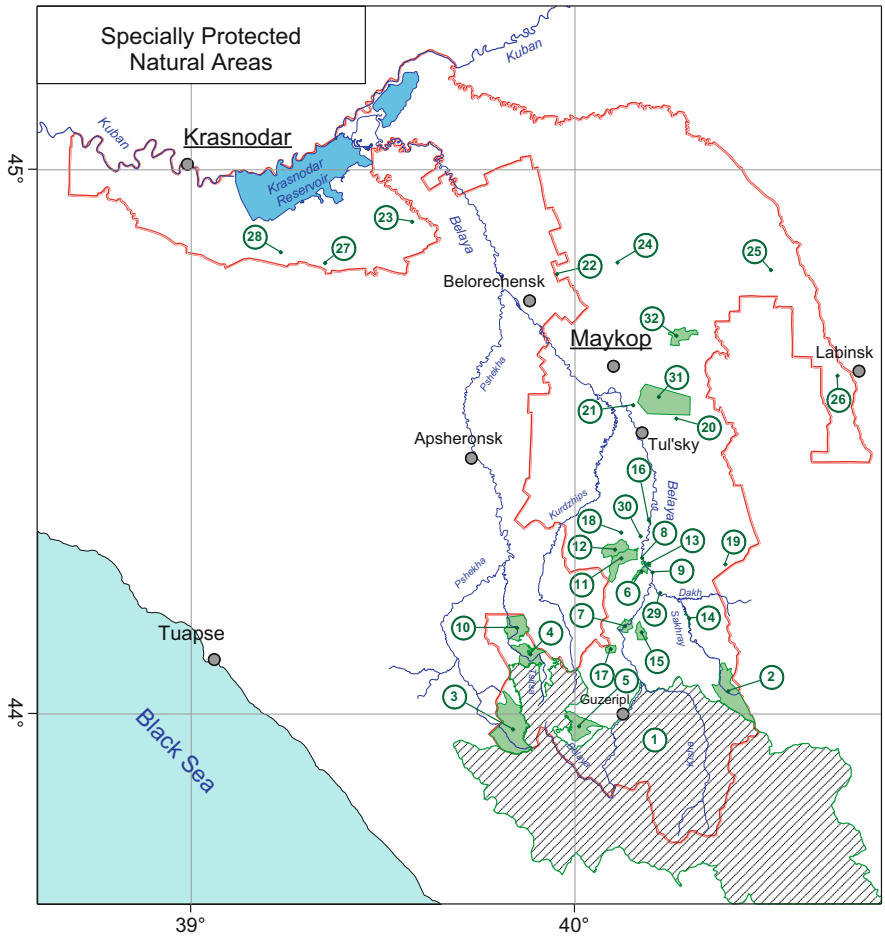
Fig. 14 Virgin forests in the mountains of the Republic of Adygea around the Guzeripl Settlement (photo by S.A. Trepet)

9 Specially Protected Natural Areas

On the territory of the Republic, there is a well-developed network of specially protected natural areas of special environmental, scientific, cultural, aesthetic, recreational, and recreational importance, for which a special protection regime has been established. The system of specially protected natural territories of the Republic of Adygea includes a State Natural Biosphere Reserve, a nature park, 2 botanical reserves, 15 nature monuments of regional significance, and 15 nature monuments of local importance (Fig. 15) (Table 5) [16]. Among them are the Caucasian State Wildlife Biosphere Reserve (Fig. 16) and 4 protected areas of regional significance with a total area of 86,218 ha, which, since 1999, have been included in the UNESCO's World Heritage List in the nomination "Western Caucasus."

10 Flora and Fauna

The diversity of flora and fauna and their preservation in the western part of the Greater Caucasus are unique not only in the Caucasus Region but also among other mountainous regions of Europe and Western Asia. This is the territory where a large number of endangered rare, endemic, and relict species of plants and animals are concentrated [17, 18]. It is especially important that the unchanged habitat of the



1	Caucasian State Wildlife Biosphere Reserve	17	Nature Monument “Monakh (Monk) Mountain & Kutanka River Waterfalls”
2	Natural Park “Bolshoy (Big) Tkhach”	18	Nature Monument “Polkovnitskaya (Colonel's) Arroyo (Creek)”
3	Nature Monument«Upper reaches of the Pshekha River and the Pshekhashkha River»	19	Nature Monument “Bear Nut Grove”
4	Nature Monument «Upper reaches of the Tsitse River”	20	Nature Monument “Quercus Araxina”
5	Nature Monument “Buynyy (Exuberant) Ridge”	21	Nature Monument “Soldier Spring”
6	Nature Monument “Rufabgo River Valley”	22	P.V. Bukreev Goncharsky Arboretum
7	Nature Monument “Granite Gorge”	23	Nature Monument “Prirodny Spring”

Fig. 15 Scheme of the location of specially protected natural areas of the Republic of Adygea (Reproduced with permission from [28])

8	Nature Monument "Khadzhokhskaya Gorge"	24	Nature Monument "Spring at the Mill"
9	Nature Monument "Kazachy (Cossack) Stone"	25	Nature Monument "Blechepsin Spring"
10	Nature Monument "Massiv (Grove) of Colchis Boxwood"	26	Nature Monument "Khodzinsky Spring"
11	Nature Monument "Aminovka River Canyon"	27	Nature Monument "Forest Park Anniversary"
12	Nature Monument "Natural Planting of Sowing Chestnut"	28	Nature Monument "Psekupskoye Urochishche"
13	Nature Monument "Meshoko Brook Canyon"	29	Nature Monument "Dakhovskaya Cave"
14	Nature Monument "Sakhray River Canyon"	30	Nature Monument "Monastyrskaya Cave"
15	Nature Monument "Syuk River Valley"	31	Maykopsky Botanical Reserve
16	Nature Monument "Ammonite Valley"	32	Kuzhorsky Botanical Reserve

Fig. 15 (continued)

most vulnerable large mammals is preserved here: bison (Fig. 17), Caucasian red deer (Fig. 18), western Caucasian round, chamois, Caucasian subspecies of brown bear, wolf, etc. The Western Caucasus is distinguished by its exceptional species richness of flora and fauna. Only in the alpine zone 967 species of vascular plants grow here. Alpine flora of other mountain systems in Russia is much poorer: Eastern Sayan Mountains, 540 species; Western Sayan Mountains, 601; Stanovoy Highlands in Transbaikal Region, 602; Ural Mountains, 621; and Altai Mountains, 297 [1].

11 Recreational Resources

The Republic of Adygea is considered to be one of the most popular tourist destinations of the Caucasus. The wildlife here is extraordinarily beautiful, the people are friendly, and the routes are accessible and safe. For more than half a century, Adygea has attracted thousands of hikers, rock climbers, mountaineers, spelunkers, and water sportsmen – amateurs and professionals from all over Russia [19–23]. Adygea has several historically established tourist areas, the oldest of which are Kamennomostsky (Khadzhokh) Village, Lago-Naki Plateau, Guzeripl Village, and Bol'shoy (Big) Tkhach Mountain. The Republic continues to develop tourism-related business: new hotels are being built, and rural tourism is growing rapidly.

Khadzhokh Recreational Region occupies a mid-level mountain range of the Republic of Adygea and embraces the neighboring of Kamennomostsky Village and Dakhovskaya Stanitsa. This region is under the reign of the Belaya River which forms two grand gorges in that place – the Granite Gorge (Fig. 19a) and the Khadzhokh Gorge (Fig. 19b). The river divides the Skalisty (Rocky) Ridge into two parts: Una-Koz Ridge on the right and Azish-Tau Ridge on the left.

Table 5 Specially protected natural areas (SPNA) of the Republic of Adygea according to http://www.prirodra.ru

No	SPNA title	District	Area (ha)
Federal significance			
1	– A. Caucasian State Wildlife Biosphere Reserve (the northern inspection department)	Maykopsky	73,356,0
	– B. Lago-Naki Biosphere Testing Ground	Maykopsky	18,174,0
Republican significance			
2	Natural Park "Bol'shoy (Big) Tkhach"	Maykopsky	3,703,0
3	Nature Monument "Upper Reaches of the Pshekha River and the Pshekhashkha River"	Maykopsky	5,776,0
4	Nature Monument "Upper Reaches of the Tsitse River"	Maykopsky	1,913,0
5	Nature Monument "Buynyy (Exuberant) Ridge"	Maykopsky	1,470,0
6	Nature Monument "Rufabgo River Valley"	Maykopsky	322,4
7	Nature Monument "Granite Gorge"	Maykopsky	556,3
8	Nature Monument "Khadzhokhskaya Gorge"	Maykopsky	5,426
9	Nature Monument "Kazachy (Cossack) Stone"	Maykopsky	0,25
10	Nature Monument "Massiv (Grove) of Colchis Boxwood"	Maykopsky	1,824,6
11	Nature Monument "Aminovka River Canyon"	Maykopsky	1,539,8
12	Nature Monument "Natural Planting of Sowing Chestnut"	Maykopsky	1,332,1
13	Nature Monument "Meshoko Brook Canyon"	Maykopsky	67,5
14	Nature Monument "Sakhray River Canyon"	Maykopsky	71,7
15	Nature Monument "Syuk River Valley"	Maykopsky	624,1
16	Nature Monument "Ammonite Valley"	Maykopsky	25,4
17	Nature Monument "Monakh (Monk) Mountain and Kutanka River Waterfalls"	Maykopsky	266,0
18	Nature Monument "Polkovnitskaya (Colonel's) Arroyo (Creek)"	Maykopsky	600,0
19	Nature Monument "Bear Nut Grove"	Maykopsky	7,5
20	Nature Monument "Quercus Araxina"	Maykopsky	400,0
21	Nature Monument "Soldier Spring"	Maykop	0,25
22	P.V. Bukreev Goncharsky Arboretum	Giaginsky	145,0
23	Nature Monument "Prirodny Spring"	Giaginsky	0.1
24	Nature Monument "Spring at the Mill"	Teuchezhsky	0.1
25	Nature Monument "Blechepsin Spring"	Koshekhablsky	0.1
26	Nature Monument "Khodzinsky Spring"	Koshekhablsky	0.1
27	Nature Monument "Forest Park Anniversary"	Teuchezhsky	20,0
28	Nature Monument "Psekupskoye Urochishche"	Teuchezhsky	5,0
29	Nature Monument "Dakhovskaya Cave"	Maykopsky	0,2
30	Nature Monument "Monastyrskaya Cave"	Maykopsky	0,3
Sanctuaries of regional significance formed for an indefinite term			
31	Maykopsky Botanical Reserve	Maykopsky	5,400,0
32	Kuzhorsky Botanical Reserve	Maykopsky	1,117,0

Fig. 16 Caucasian State Wildlife Biosphere Reserve. Mountain Fisht. View from the top of the Mountain Pshekha-Su (photo by S.A. Trepet)

Fig. 17 Caucasian bison (photo by S.A. Trepet)

Fig. 18 Caucasian red deer (photo by S.A. Trepet)

(a) (b)

Fig. 19 Granite Gorge (**a**) and Khadzhokh Gorge (**b**) on the Belaya River (photo by S.A. Trepet)

The Republic of Adygea is known for its history. Multiple burial mounds and dolmens remind about the ancient culture. There is historical evidence of the ancient Greeks, Romans, Genoese, and Turks residing there. The Adyghe tribes were known to have lived here since ancient times. There were many Abadzekh villages, called auls, spreading out one after another for many kilometers. The foundations of old auls, medieval settlements, and Caucasian War fortifications are still to be seen today. This is the land of many legends; the legends of Circassian Stone (also called Cossack Stone or Devichiy (Girl's) Stone), Rufabgo, and Shkhaguashche were born there [4].

This area is rightly considered as one of the oldest recreational centers of the Western Caucasus. All hiking routes of this part of the Caucasian mountains would start here from Gornaya Tourist Center. Khadzhokh is an intersection of many tourist routes of Adygea. From here, people set off to hike the valleys of the Dakh, Sakhray, Khodz, Fars, Aminovka, and Meshoko rivers; this is also a trailhead for the route leading to the famous Svyato-Mikhalovsky (St. Michael's) Monastery (Fig. 20) at the foothill of Mount Fiziabgo. The area contains a great number of natural landmarks, such as the valleys of the Meshoko (Fig. 21a), Aminovka rivers (Fig. 21b), Rufabgo (Fig. 22), and Khadzhokh Gorge (Fig. 19b).

Bol'shoy (Big) Tkhach Recreational Region (Fig. 23) lies along the northern border of the Caucasian State Wildlife Biosphere Reserve and includes the well-preserved natural complexes of Bol'shoy (Big) Sakhray (Fig. 24), the Kuna, Afonka, and Slesarnya rivers basins.

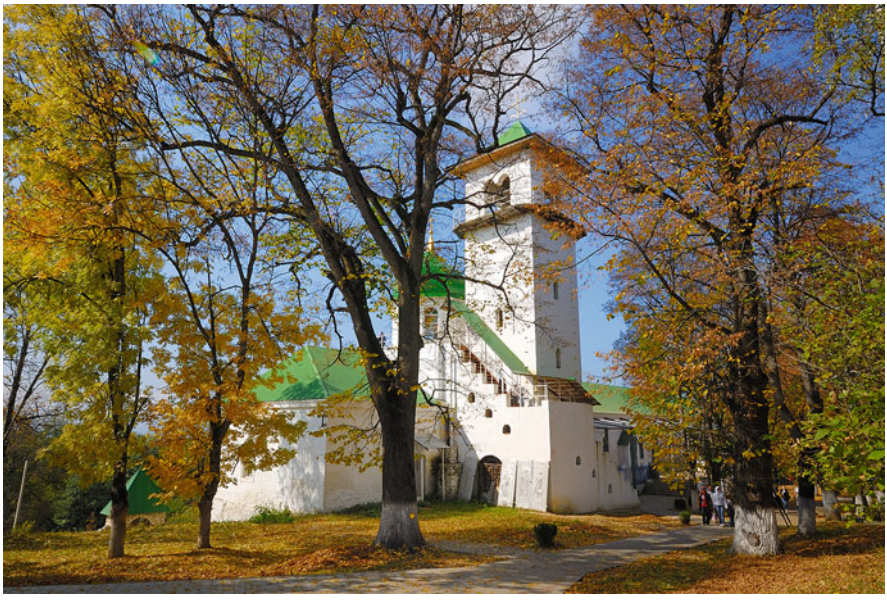


Fig. 20 Svyato-Mikhalovsky Monastery (photo by S.A. Trepet)

Fig. 21 Waterfalls of River Aminovka (**a**) and River Meshoko (**b**) (photo by S.A. Trepet)

The mountain ridge forms the basis of the region's relief. It spreads from the northwest to the southwest and is included into the system of the Peredovoy (Forward) Mountain Range. Its greatest element is the Bol'shoy (Big) Tkhach Mountain Range which is the main tourist destination in this region. One of the central elements of the region is the mountain pass called Chertovy Vorota (Devil's Gates) (Fig. 25) or Acheshboki in the Adyghe Language, the completely unusual outlines of which generated scores of myths and legends. Among the variety of fauna in the Bol'shoy Tkhach area, Caucasian bison and red deer is of particular interest.

The major sightseeing attraction of this region is Bol'shoy Tkhach National Park with its total area of 3,700 ha. The park was created in 1997 under a special decree of the Republic of Adygea President. On November 30, 1999, at the 23rd Session of the UNESCO's World Heritage Committee in Marrakech (Morocco), Bol'shoy Tkhach National Park, along with such nature landmarks as Buynyy (Exuberant) Ridge, the Pshekha River, and the upper reaches of the Tsitse River, and the Caucasian State Wildlife Biosphere Reserve were included in the UNESCO's World Heritage List under the name of "West Caucasus."

Tourists have been attracted to this region relatively recently. For the last two centuries, the upper Sakhray Region has been under constant exploitation of forest, pasture, and hunting resources. Exploitation of forests and woods especially increased after the end of the Caucasian War (1817–1864). In 1864, Sakhray Village

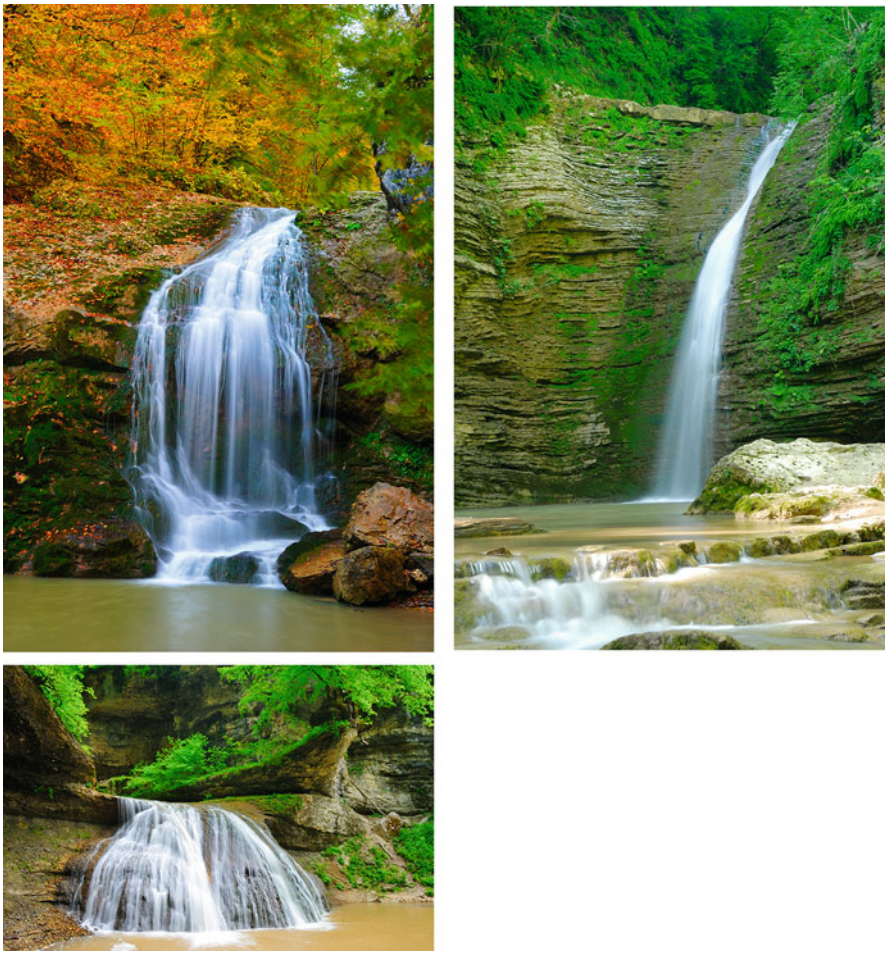


Fig. 22 Rufabgo River waterfalls (photo by S.A. Trepet)

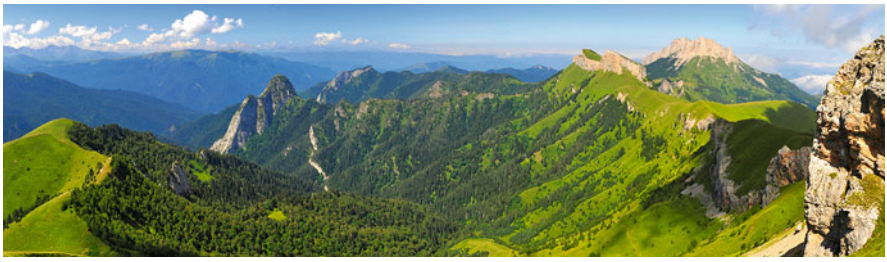


Fig. 23 Bol'shoy Tkhach Recreational Region (photo by S.A. Trepet)

Fig. 24 Mountain Bol'shoy Tkhach (photo by S.A. Trepet)

Fig. 25 Mountain pass Chertovy Vorota (Devil's Gates) (photo by S.A. Trepet)

was established, which was settled by the "middle class" of Maykop and timber merchants. Lots of old Circassian orchards were cut down in those years. Having beautiful wood texture, the orchard trees were in high demand in timber and furniture industries. The guard of forests in the Sakhray vicinity started only after the professional forest ranger watch had been organized to guard Grand Duke's hunting grounds, which bordered the line along the Khamyshki, Novoprokhladnoe (Sakhray), and Psebay villages. Even Grand Duke himself had to get a special royal permission to be able to hunt there. This led to gradual restoration of the number of wild animal species.

Pasture cattle-breeding, as well as hunting, has always been well-developed there. The Chertovy Vorota (Devil's Gates) Mountain pass served the Circassian people as a bridge between the northern forested foothills and accessible mountain pastures, situated further to the south, in the Bambachka River Valley. The traces of ancient shepherds' cattle pens are still well-preserved in the Port-Artur Mountain Range. This region was used for pastures mainly by the Adyghe tribe of Abadzekh people. Cattle-driving paths led to the pass from all around. Main paths connected Bol'shoy Tkhach, situated to the north of the pass, with the territories on the left bank of the middle Urushten River, and its tributaries.

Recreational Region of Lago-Naki Plateau is situated between the Belaya and the Pshekha rivers and represents an isolated limestone area of the western part of the Caucasus. It presents a system of the following mountain ranges, Kamennoye More (Stone Sea) (Fig. 26), Nagoy-Chuk, Abadzesh, and Utyug (Iron), and mountains, Fisht (Fig. 27), Oshten (Fig. 28), and Pshekha-Su. Fisht (2,867 m) is the highest peak

Fig. 26 Kamennoye More (Stone Sea) Range (photo by S.A. Trepet)

Fig. 27 Mountain Fisht (photo by S.A. Trepet)

Fig. 28 Mountain Oshten (photo by S.A. Trepet)

of the Lago-Naki Mountain Ridge. This relatively small region (650 km^2) features all forms of glaciers (spur valleys, circuses, and moraines) and karsts (multiple karst cavities – wells, craters, and caves, often with underground rivers). The upper rivers form deep river canyons (the Guamskoye Gorge, the Mezmay Canyon, and the Tsitse Gorge). This is also the place where the Kurdzhips River begins, its upstream forming a young valley called "Sukhoy Zhelob" (Dry Gutter) on the elevated part of the Lago-Naki Plateau. Explorer of this region, P.S. Lozovoy, once said, "Lago-Naki is a set of amazing nature monuments and mesmerizing landscapes; it represents an exceptional variety and uniqueness of natural beauty" [22].

Lago-Naki Plateau is one of the most popular recreational regions of the West Caucasus. Tourists started to explore this region actively only at the end of the 1940s, after the central regions of the Caucasian State Wildlife Biosphere Reserve had become a strictly protected zone (1947).

The route named "Through the Belorechensky Pass" was described in 1948 as an amateur route; it connected the village of Guzeripl Village, Partizanskaya Polyana (glade), the head of the Belaya River, Belorechensky Pass, Babuk-Aul Cordon, Solokhaul and Dagomys villages, and Sochi City on the Black Sea coast. The route lay along "Old Circassian Trail" which was founded by the Adyghe people in the times of the Osman Empire for the purposes of trade and cattle driving to Turkey. The first tourist groups tried this route out in 1949. The same year, "Along the West Caucasus," a famous all-union tourist route N 30, was opened. It replaced the "Through the Belorechensky Pass" route. In 1950, 30 groups of total 877 people hiked this route. In 1974, a new hiking route N 825 named "Through Adygea to the Black Sea" was opened. The walking part of the route connected Lago-Naki Tourist Center, the Abadzeshsky Pass, Rubleny (Chopped) and Vodopadny (Waterfall) shelters, the Cherkessky Pass, Babuk-Aul and Solokhaul shelters, and the Lazarevskoe Village on the Black Sea coast.

Today, Lago-Naki Plateau still offers wide opportunities and prospects for the development of practically all modern kinds of tourism. There are traditional routes for hiking and mountaineering, alpinism, and mountain climbing. From the athletic point of view, Fisht-Oshten Mountain junction is the most interesting; North Caucasus Regional Search and Rescue Service worked out routes of various difficulty levels for it.

There are many caves – objects of interest for speleotourism – in almost all plateaus, mountain peaks, and mountain ridges of Lago-Naki. These caves often have horizontal underground galleries extending for several kilometers and deep wells. The difficulty levels of exploring Lago-Naki cavities vary from the lowest (Bolshaya (Big) Azishskaya (Fig. 7), Ozernaya (Lake), Lubava (Fig. 29), Ovech'ya (Lambs)) to the highest, requiring special training, outfit, and equipment accessible only to professional spelunkers: Absolyutnaya (Absolute), Universitetskaya (University), Paryashchaya Ptitsa (Soaring Bird), Krestik (Cross), and Tourist.

In the upland region of Lago-Naki, winter tourism (Fig. 30) and alpine skiing (Fig. 31) are being actively developed.

Guzeripl Recreational Region occupies the southern part of the Republic of Adygea and includes the slopes of the Belaya River Valley on the territory between

Fig. 29 Cave Lubava (photo by S.A. Trepet)

Fig. 30 Dog sledding on the Lago-Naki Plateau (photo by S.A. Trepet)

Fig. 31 Snowmobiles on the Lago-Naki Plateau (photo by S.A. Trepet)

Guzeripl (Fig. 32) and Khamyshki Villages. As early as in the nineteenth century, this part of the Belaya River Valley was occupied by a great number of Circassian settlements; and nowadays, the Khamyshki Village stands on the site of a big Abadzekh aul. From 1888 to 1909, this territory was a part of Grand Duke's hunting grounds in Kuban. In the first years of the Soviet rule, exiled settlers appeared in Guzeripl, many of whom later became the rangers of the Caucasian State Wildlife Reserve founded in 1924. The construction of the dirt road from Khamyshki to Guzeripl in 1928–1930 promoted the development of timber industry in the area. Intensive and continuous deforestation carried out up till the 1990s substantially changed the appearance of the forested mountain range surrounding the Belaya River Valley. Fortunately, the protected side of the abovementioned area remained virtually unharmed. The preserved ancient forests, from middle-aged trees to those 200–300 years old, give the region its fantastic scenic touch and evoke a sense of its genuine untamed and primitive nature (Fig. 32).

The Guzeripl area is one of the most beautiful recreational centers in the Western Caucasus. It is there that one can enjoy breathtaking vistas of the highest peaks of Adygea: Mountain Chugush (3,238 m) (Fig. 3), Mountain Dzhemaruk (3,099 m), Mountain Tybga (3,064 m) (Fig. 4), and Mountain Urushten (3,020 m). The first planned hiking tours from Guzeripl to the Caucasian State Wildlife Biosphere Reserve began as early as in 1930, when Lagerny Cordon-Guzeripl-Krasnaya Polyana (Red glade) route was included into the list of major tourist routes of the USSR on the approval of the Society of Proletarian Tourism. From Guzeripl, the tourists went into two directions – to the Lago-Naki Plateau heading further to the

Fig. 32 Guzeripl Village (photo by S.A. Trepet)

Fig. 33 Rafting competitions “Interrally Belaya River” (photo by S.A. Trepet)

Black Sea and to the southeast in the direction of Psebay and Krasnaya Polyana (Red glade). Despite the fact that from the mid-1970s many of these hiking tours had been discontinued, Guzeripl Recreational Region is still extremely popular among tourists. The southern border of the region is only 17 km away from the infrastructure of Sochi Winter Olympic Games of 2014.

Presently, the recreation industry there combines big hotel complexes, rapidly developing small tourist businesses, and rural tourism. In more than 40 years, rafting competitions "Interrally Belaya River" are held here (Fig. 33). "Interrally Belaya River" has turned this sports event into an extremely popular spring festival which attracts scores of holiday-makers from all over Russia and abroad.

12 Conclusions

The Republic of Adygea is characterized by great natural diversity and natural resource potential. Thanks to its unique nature, the Republic of Adygea is considered to be one of the most popular tourist destinations of the Caucasus. The wildlife here is extraordinarily beautiful, the people are friendly, and the routes are accessible and safe. For more than half a century, Adygea has attracted thousands of hikers, rock climbers, mountaineers, spelunkers, and water sportsmen from all over Russia. Adygea has several historically established tourist areas, the oldest of which are Kamennomostsky (Khadzhokh) Village, Lago-Naki Plateau, Guzeripl Village, Bol'shoy (Big) Tkhach, and Fisht Mountains. The Republic continues to develop tourism-related business: new hotels are being built, and rural tourism is growing rapidly [23]. Since 1999, the Caucasian State Wildlife Biosphere Reserve and four protected areas of regional significance with a total area of 86,218 ha have been included in the UNESCO's World Heritage List in the nomination "Western Caucasus." In this respect, the issues of assessing the permissible recreational load on the territory, developing tools for justifying, and making managerial decisions taking into account ecological capacity of the territory are of special concern. Tourist development of the territory should not damage the fragile natural environment of the Republic of Adygea [23].

On the other hand, there is a set of environmental issues related to the development of industry, agriculture, and energy resources in the Republic of Adygea. In the large cities, one of the main environmental problems is soil contamination with heavy metals and oil products resulted from city transport, housing, and public services. Pollutants enter soil through precipitation and leaf and branch shedding, deposit from the air, and are directly absorbed by soil [24]. The increase in the number of vehicles and cargo transportation also causes an increase of nitrogen oxides, sulfur, carbon, lead compounds, hydrocarbons, benzapyrene, and other harmful substances in the surface layers of the atmosphere [25]. In rural areas, the main environmental issues are related with a development of agricultural sector, which in order to increase yield, as well as protect and improve the results of crop storage, uses the mineral fertilizers, chemical pest, and disease control agents for cultivated agricultural plants and weeds (disinfectants, pesticides such as fungicides,

insecticides, the use of chemical sterilization of the soil like phytotoxicants, herbicides, defoliants, etc.). In this way, some of the chemicals enter the river network.

The basin of the Belaya River is a natural and anthropogenic system with interactions of natural, urbanized, and agrarian landscapes. On its banks, there are a large number of big and mid-sized settlements with a quite developed network of agricultural and industrial enterprises, which cause contamination of the Belaya River water and sediments with heavy metals [26]. Further development of industry and agriculture will exacerbate this problem.

Finally, regional climate change and extreme weather events also can have an impact on the environment of the Republic of Adygea. Examples include a diversity of effects from exogenous processes in the mountains and on the plain, siltation, overgrowing, and bloom events in water reservoirs to appearance and certain domination of alien plants in the mountains of Adygea.

In the coming years, environmental factors will have a major impact on the socioeconomic sustainable development of the Republic of Adygea. Taking into account that the anthropogenic load on ecological systems is constantly increasing, the development of the Republic economy should be ensured by a set of measures for the preservation of the unique natural environment, maintaining health and improving the quality of life of local population [27, 28].

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References

1. Buzarov AS, Varshanina TP, Kabayan NV, Krasnopolskiy AV, Krasnopolskaya NV, Kuasheva DA, Melnikova TN, Spesivtsev PA, Khachegogu AY, Shebzukhova EA (2001) Geography of the Republic of Adygea. Adyghe Republican Book Publishing House, Maykop. 200 pp (in Russian)
2. The Atlas of the Republic of Adygea (2005) Publishing House "Lev Tolstoy", Maykop, 79 pp (in Russian)
3. Lebedev SA, Kostianoy AG, Kravchenko PN (2020) Three-dimensional topographic model of the Republic of Adygea. In: Bedanokov MK, Lebedev SA, Kostianoy AG (eds) The Republic of Adygea environment. Springer, Cham
4. Bormotov IV (2009) Mountain Adygea. Polygraph Publishing House, Novosibirsk. 96 pp (in Russian)
5. Bedanokov MK, Berzegova RB, Kuizheva SK (2017) Atmospheric disturbances in the airflow around mountains and the problem of flight safety in the mountains of the Republic of Adygeya. Ecol Montenegrina 14:136–142

6. Varshanina TP, Mitusov DV (2005) Climatic resources of landscapes of the Republic of Adygea. Publishing House of Adygea State University, Maykop. 237 pp (in Russian)
7. Kiseleva SV, Korinevich LA, Lebedev SA (2017) Assessment of the renewable energy potential in the Republic of Adygeya. Ecol Montenegrina 14:143–151
8. Melnikova TN (2018) Ecological monitoring of reservoirs of the Republic of Adygea. In: Sovremennyye problemy nauki i obrazovaniya (Modern issues of science and education), vol N1, pp 12–14. (in Russian)
9. Cheredeev IV, Maksimenko MY (1987) Hydrogeology of thermal water of Adygea protrusion. Kubangasprom, Krasnodar. 242 pp (in Russian)
10. Kiseleva SV, Korinevich LA, Lebedev SA (2020) Renewable energy potential in the Republic of Adygea. In: Bedanokov MK, Lebedev SA, Kostianoy AG (eds) The Republic of Adygea environment. Springer, Cham
11. The report on the state and use of land in the Republic of Adygea following the results of 2017 (2018) Office of the Federal Service for State Registration, Cadastre and Cartography of the Republic of Adygea, Maykop, 189 pp (in Russian)
12. Macht VA, Makenova SK, Karpova OA (2017) The analysis of the existing method of land classification. Bull Voronezh State Agrarian Univ 1(52):253–258. https://doi.org/10.17238/issn2071-2243.2017.1.253. (in Russian)
13. Khasanova-Bibalova LV (2003) Ecological features of the biodiversity of Adygea. Republican Publishing-Polygraphic enterprise "Adygea", Maykop. 160 pp (in Russian)
14. Berzegova AA (2008) Wild-fruit forests of the Adygea region, the prospects of their utilization. Bull Mari State Tech Univ Ser For Ecol Nat Manag 1:29–33. (in Russian)
15. Varshanina TP, Mitusov DV (2005) Climatic resources landscapes of the Republic of Adygea. Publisher of the Adyghe State University, Maykop. 237 pp (in Russian)
16. Regional problems of specially protected natural territories: on the example of the Republic of Adygea (2003) Kachestvo, Maykop, 237 pp (in Russian)
17. The Red Data Book of Republic of Adygea: Rare and Threatened Representatives of the Regional Fauna and Flora (2000) Part 1. Introduction. Vegetabilia and Mycota.2nd edn. Kachestvo, Maykop. 340 pp (in Russian)
18. The Red Data Book of Republic of Adygea: Rare and Threatened Representatives of the Regional Fauna and Flora (2000) Part 2. Animals.2nd edn. Kachestvo, Maykop. 376 pp (in Russian)
19. Sheujen AK (ed) (1999) Recreational resources of Adygea. RIPO "Adygea", Maykop. 272 pp (in Russian)
20. Smolyakova YI (2008) Tourism in the Republic of Adygea: organization, resources, limiters. New Technol N5:104–108. (in Russian)
21. Karpova YI, Ryzhivolova EA, Dymova MY Tourism development in the Republic of Adygea. In: Tourist and recreational complex in the regional development system, pp 127–130. (in Russian)
22. Lozovoy SP (1984) Lago-Naki highlands. Krasnodar Book Publishing House, Krasnodar. 160 pp (in Russian)
23. Bedanokov MK, Chich SK, Chetyz DY (2020) Ecological tourism development in the Republic of Adygea. In: Bedanokov MK, Lebedev SA, Kostianoy AG (eds) The Republic of Adygea environment. Springer, Cham
24. Sirotyuk EA, Zhemadukova SR (2020) Maykop City soil quality determination based on the analysis of soil algae and cyanobacteria content. In: Bedanokov MK, Lebedev SA, Kostianoy AG (eds) The Republic of Adygea environment. Springer, Cham
25. Lebedev SA, Guk GA, Apukhtina EM (2020) The Republic of Adygea motor transport complex impact on the regional environment. In: Bedanokov MK, Lebedev SA, Kostianoy AG (eds) The Republic of Adygea environment. Springer, Cham
26. Toroyan RA, Takh IP (2020) Spatial distribution of heavy metals content in the river Belaya ecosystem. In: Bedanokov MK, Lebedev SA, Kostianoy AG (eds) The Republic of Adygea environment. Springer, Cham

27. Dorgushaova AK, Ashinova MK, Kuizheva SK, Zarubin VI, Kalashaova MK (2020) Improvement of the mechanism of the regional ecological and economic system regulation. In: Bedanokov MK, Lebedev SA, Kostianoy AG (eds) The Republic of Adygea environment. Springer, Cham
28. Zaretskaya MG, Kurbanova EM, Temzokov AK, Shazzo AA, Shefrukova ST (2020) Problems of legal regulation of environmental relations in the Republic of Adygea and possibilities of environmental insurance. In: Bedanokov MK, Lebedev SA, Kostianoy AG (eds) The Republic of Adygea environment. Springer, Cham. https://doi.org/10.1007/698_2020_501