# Chapter 2
# The Pirin Mountains as a Model Region

**Abstract** The northern part of the Pirin Mountains with its distinctive marble peaks and silicate areas constitutes our central area of study. Very differentiated geomorphologic landforms, soil types, micro-habitats and biodiversity are found in the subalpine region and, because there is marginal anthropogenic interference, we can study natural landscape and climate dynamics. To establish a basis, all geophysical features on specific sites and along transects have been documented, and the soil conditions have been mapped. The region's service capacity and conservation strategies are outlined. Hence, this chapter reviews important aspects of the Pirin's remarkable landscape, its natural development (climate, vegetation, soil) and anthropogenic interference (history, current pressure).

**Keywords** Landscape types • National Park Pirin • Physical-geography • Soil map • Use characteristic

## 2.1 Location and Ecosystem Characteristics

The mountains in Southwestern Bulgaria are assigned to the Rhodopes Massif (also Rila-Rhodopes Massif or Thracian Massif) and to the Serbo-Macedonian Massif (Fig. 2.1), which occupies swaths of Serbia, southern Bulgaria, Macedonia, Greco-Macedonia and Greco-Thrace (Ager 1980). The highly dissected character of this region is remarkable. The small mountains, which are not exceeding 2,925 m a.s.l. (Peak Musala in Rila), are manifold structured by intramontane basins (e.g. the Basin of Razlog, Simitli Basin) and deep graben valleys (Struma Graben, Mesta Graben) as well as by transverse valleys and rises (e.g. Kresna Rise) (Grunewald et al. 1999). Furthermore, nearly all of these mountains exhibit steep north flanks and comparatively gently inclined south flanks (Schröder and Berkner 1986).

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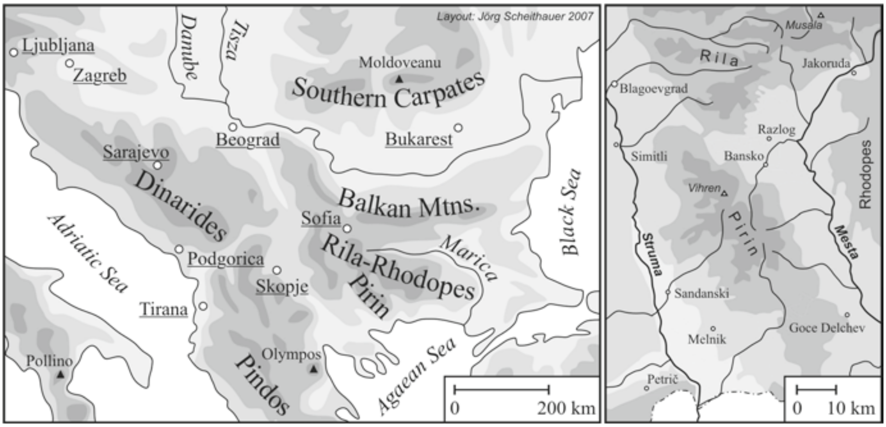



**Fig. 2.1** Balkan Peninsula (*left*), Southwest Bulgaria and Pirin Mountains (*right*) – location and structure: mosaic of mountains, basins and valleys

The region is characterized by high seismic activity, numerous thermal springs and post volcanic phenomena (e.g. in Sandanski, Rupite, Sapareva Banya) which indicate tectonic disturbances between the mountains. Pediments and dispersal fans which, due to strong erosion, often emerge as badlands or earth pyramids (around Melnik, Stob, Djerman), are typical at the edges of the intramontane basins as well as partly thick Tertiary and Quaternary accumulations of littoral, estuary, limnic and fluvial genesis in the central parts (Grunewald and Stoilov 1998).

Moraines, cirques, trough valleys and a diversity of periglacial forms with rectilinear slopes and patterned soils prove the Pleistocene glaciations of the Rila and Pirin Mountains (Batakliev 1972; Schröder and Berkner 1986). In the northern Pirin Mountains, small recent glacierets are found (see Chapter 4, Section 4.2).

In the east and the west, the Pirin is seamed by almost parallel disturbances marked by the two main streams, the Struma and Mesta. It impressively overtops its valleys and basins as a single horst. Its main axis has a NW-SE expansion of approximately 70 km and a mean width of 35 km (Fig. 2.1). The northern transition to the Rila Mountains and the southern transition to the Slavyanka Mountains (Paril Pass 1,170 m a.s.l.) are less distinctively formed as saddles. More than 50 peaks within the Pirin Mountains reach altitudes above 2,600 m a.s.l.

The Pirin Mountains can be geologic-morphologically subdivided as follows:

- The high northern part, which extends from Predel Pass to Todor's meadow (Todorova polyana) with characteristically rich dissected alpidic and glacial forms as well as marble peaks (e.g. pyramidal peak Vihren, 2,914 m a.s.l.) and
- The central and southern part with dominant crystalline rocks, rounder forms and maximum altitudes of about 2,000 m a.s.l

An analogy between the spatial distribution of relief-determinate landscape categories and land use types is observed in the study area. Based on the works of Anonymous (1977) and Grunewald et al. (1999), we distinguish following areas of chorological dimension:

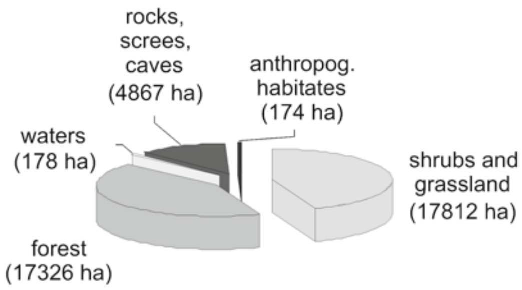



**Fig. 2.2** Share of ecosystem types in the Pirin National Park (Anonymous 2003)

1. Mesohemerobe grasslands and steppes of the southern intramontane basins with Quaternary loose sediments, Pliocene sandy-loamy sediments or intrusions of metamorphic rocks
2. Meso to oligohemerobe moderately humid mountain forest landscapes with mixed forests on metamorphic rocks and coniferous forests on intrusive, marble, schist and gneiss
3. Oligo to ahemerobe high mountain landscapes with subalpine meadow-shrub communities, alpine meadows on marble, intrusive, crystalline schist and gneiss and alpine rock and debris landscapes

Due to its unique and beautiful landscapes, and its high biodiversity, a part of the Pirin Mountains is a National Park (NP). The geoecotypes in the NP were mapped following the classification of Palaearctic Habitats (Nature and Environment No. 78/96). Figure 2.2 illustrates the predominance of forests and (above timberline) open areas. Habitats with anthropogenic impact account for 2.2% of the whole area. Hence, the study area is particularly suitable for monitoring natural, mainly climate-driven, changes.

## 2.2 Geology and Morphodynamic

The Pirin as a horst-blocked highland morphostructure in the western part of the Rila-Rhodopes-Massif was considered a consolidated Precambrian block that separates the alpidic northern mountains (Balkanides) from the southern mountains (Hellenides) as a type of intermediate massif. However, investigations in the 1960s revealed an involvement of the alpidic dynamic for swaths of the Rila-Rhodopes-Massif (Kockel and Walther 1965). The rock mass built up by crystalline rocks is composed of two structural levels. The lower one consists of gneiss and anatexites, whereas the upper one is composed of high metamorphic gneiss, amphibolites and Proterocoic marble.

In the west, the massif is relatively sharp, limited by a disturbance named the Struma-(Strimon-) Line. Here, in the borderland to Macedonia and Serbia, the series of the adjacent Serbo-Macedonian-Massif overthrust the Rila-Rhodopes-Massif.

Due to strong lateral pressure, the Variscan Pirin Mountains and the Basin of Razlog were lifted up like a horst and lowered, respectively. Probably having its climax during Upper Cretaceous, these tectonic processes were accompanied by active volcanism (Burg et al. 1990).

The Pirin itself is characterized by cross faults in metamorphic rocks. The lower part of the mountains is composed of granite, whereas marble and limestone constitute the upper parts. Within the marble part there are embedded granite structures that form three bulges. These structures determine the typical oblong dome-like shape of the massif. Due to erosive processes, the crystalline rocks that were under layers of sediment and marble are exposed on the surface (Georgiev 1991). Consequently, the study area is split into two petrographic parts (Fig. 2.3): marble and silicate, which affect major landforms as well as soil properties, stream

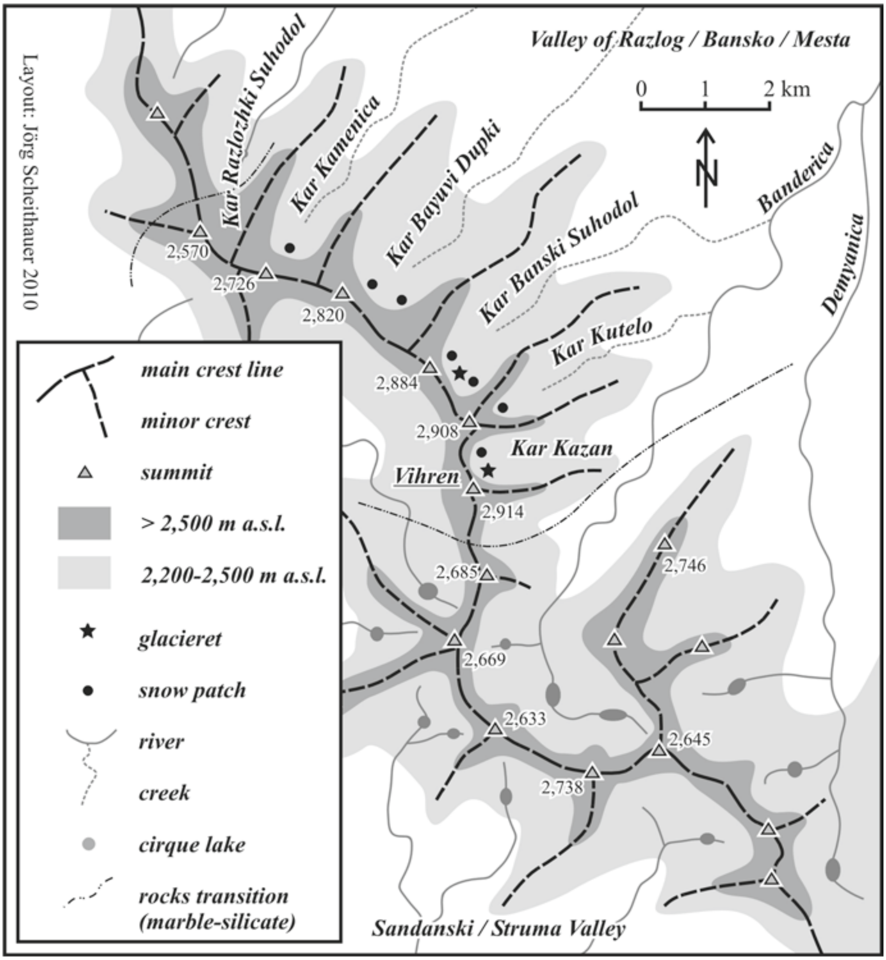



**Fig. 2.3** Main crest and cirques of northern Pirin Mountains

networks and vegetation. In terms of area, the dominating rock is granite. Within Pirin National Park, granite accounts for 62% of the area followed by gneiss with 14% and marble with 12%. Schist and glacial rubble account for 5% each (Anonymous 2003).

Traces of the intermittently proceeded Tertiary block movements are found in three levels of denudation, whose erosion surfaces in parts that have recently been covered with meadows (locally called Polyana or Livadi). For instance, located west of the main divide, there are the Golyamo and Malko Spano Pole and the Banderizhka Polyana, which now serve as locations for the Bansko cable car station and a biathlon stadium.

Characteristic of the Pirin Mountains, the northern part in particular, are the large cirques (35 in number, locally known as "circus") and trough valleys (Grunewald et al. 1999). Most cirques are found within the granite parts of the northern Pirin, which is located to the east of the main divide and marked by the headwaters of the Banderica, Demyanica, Bezbozhka Reka, Retize, Kamenica and Tufcha rivers. Many of these cirques bear lakes. One half each of the cirque floors is situated in approximately 2,200 or 2,400 m a.s.l., which argues for two independent glacial stages: Riss and Würm glaciation (Louis 1930, Popov 1962). The snow line at that time is estimated to have been at an altitude of 2,200–2,300 m a.s.l. Within the marble parts, cirques are smaller (areal) but deeper than in silicate parts.

The most profound features of valley glaciation are evident alongside the Demyanica, Banderica, Retize, Vlahinska Reka and Pirinska Bistrica rivers. Remains of moraines are found in the valley of Demyanica down to an altitude of 1,140 m a.s.l., which suggests a valley glacier of 12 km maximum length. The remains in the other valleys merely reach down to 1,570–1,750 m a.s.l. The differences in levels can only be explained by differences in exposition and by the extent of the accumulation area (Schröder and Berkner 1986).

Even though marble usually shows marginal tendencies to karstification, different forms exist. The most common forms are dolines which, in the northern Pirin, mostly have developed as shaft-like small-sized dolines with irregular shapes and fallen blocks covering the floor. Lacking fine sediment, they have a low water-retaining capacity. Even if located in the lower parts of the cirques, they do not bear lakes. Several bear fields of firn periodically or even permanently. Characteristic valleys with karst drainage are called dry valleys in the Pirin Mountains (Banderizhki Suhodol, Razlozhki Suhodol). Karrens, or other karst forms, are only slightly developed. Caves, mostly with vertical orientation, are mainly developed in the contact area between granite and marble (Grunewald et al. 1999; Anonymous 2003).

The absolute altitude difference in the northern Pirin amounts to approximately 1,900 m a.s.l. between Bansko and Vihren Peak, and into Struma Valley near Kresna 1,750 m a.s.l. in turn (air-line distance approximately 15 km). The steep relief in high altitude areas, depending on climatic and geologic premises, results in processes that involve typical morphologic structures for high mountain regions. Of particular mention is the mass-shifting with all its characteristic processes like avalanches, rock slides, mud torrents and floods. Recent erosive processes are marginal on sites with closed forest vegetation. In particular, human interference poses the potential of natural catastrophes. More than 90% of the NP's area features steep (21–30° slope) and highly steep (>30°) relief (Anonymous 2003).

Outlined below are recently developed structures and processes within the study area above the timberline, mapped by Engler (2006). The basic principles for mapping are, among others, the workings of Demek et al. (1976), Lehmkuhl (1989) and Ries (1994). Intensive frost weathering in high altitude areas produces glacial debris, which can be shifted gravitatively, particularly in the crystalline areas. In large part, the debris is scattered extensively over the slopes or accumulated in closed hollows (Fig. 2.4a and b). According to Rathjens (1982), this zone also is called the glacial debris level. This is the belt of free solifluction. By night, frost-weathered material is held together by frozen ice; by daytime, when the sun melts the ice, stones release. Radiation-controlled diurnal temperature variations cause similar effects. Therefore, eastern and southern slopes, in particular, are in danger of falling rock.

While no glacial debris is found on marble crests, there is a special phenomenon of the solifluction belt: rectilinear slopes formed by debris corrosion of soil flow (Fig. 2.4c, cf. Schröder and Berkner 1986). Areal erosion is caused by frequent freezing and thawing of moist soils, accompanied by the development of rectilinear slopes, solifluction lobes, loop bedding soils or the typical patterned ground (Schröder and Berkner 1986, Veit 2002). Extensive erosion forms and rudimental patterned grounds can be found on erosion surfaces. The example illustrated in Fig. 2.4d shows a slump, characterized by the tilt of material alongside a slope parallel line and the disaggregation of the slipping mass into several blocks (Veit 2002). Caused by the rotation of the material, coarse debris from deeper soil layers can be conveyed to the surface. Shell-shaped cracks are typical as well.

Within the belt of free solifluction, on steep slopes, primarily polygonal debris is found, which accumulates to alluvial cones and rock fans, partly obscuring the glacial forms. Often, smaller cirques are completely blocked up (Fig. 2.4b). Rock falls can form rock fall gullies and accumulate the transported material on rock fans (Fig. 2.4e). Such local hollows are predestined for avalanches. The extreme examples are rock falls or mountain creeps. In particular, endangered gullies with rubble slope accumulated are found on hollow slopes with access to open rock.

During winter until early summer, the alpine level of the study area is under nival influence. Snow is likely to accumulate to nivation cirques in hollow moulds and erosive work is performed by meltwater in so-called nivation spouts and rills. In the marble parts of the northern Pirin, the thawing period is characterized by a processes of solution-weathering and karstification. Soils are under the stress of snow erosion, which becomes obvious in so-called blaikens.

If gravity is accompanied by moisture as a slip agent, processes like landslides, filled valleys, soil creeping, mud flow and debris glaciers occur (Ahnert 1999). The belt of impeded solifluction features a closed vegetation cover, which decelerates erosion. The slope-parallel morphologic tendencies manifest in cryoplanation terraces, solifluction folds and loop bedding meadows (Rathjens 1982). Soil creeping processes mainly proceed on rectilinear or expanded concave slopes on marble with

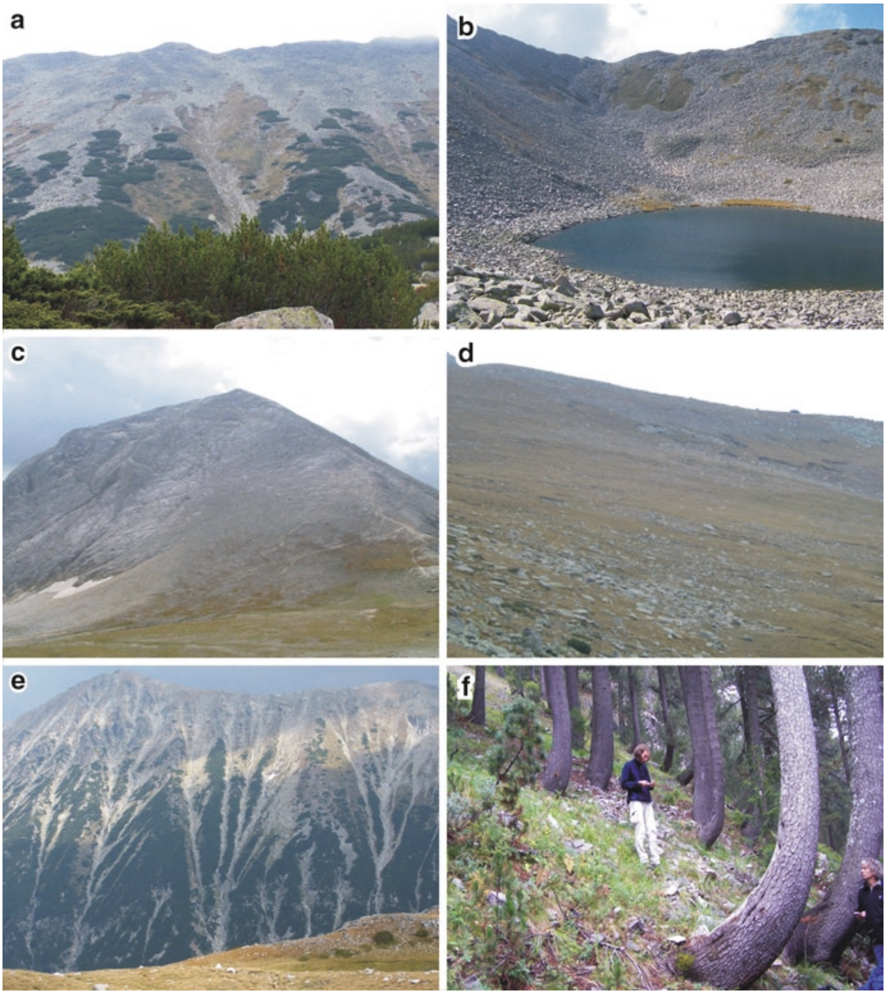



**Fig. 2.4** Selected examples of natural morphodynamic in northern Pirin Mountains: (**a**) areal debris, (**b**) accumulated debris in the upper, crystalline Banderica Valley, (**c**) marble rectilinear slopes at the Vihren, (**d**) widespread erosional forms upsite the Spano Pole meadow, (**e**) cutted, elongated steep slope at Todorin peak and (**f**) significant bole sweep

a comparatively strong inclination. Distinctive bole sweeps on trees indicate these processes (Fig. 2.4f). Another fortifying factor for these creeping processes is shallow, imbued, clayey-loamy soils. Snow can further enforce pressure and growth deformation.

Last but not least, human interference affects the high mountain morphodynamic. Grazing animals usually move slope-parallel, producing a distinctive cattle trampling relief. Hikers in summer damage vegetation, sparking erosion (Fig. 2.5a, b).

Clearing of forests and krummholz (elfin-tree) woodlands adds up to further destabilization of slopes, which can bring about disastrous erosive events like mud torrents or linear gully erosion. Figure 2.5c and d document such recent events in Pirin NP. Morphology is also controlled indirectly by interferences on surface water (water relocation, discharge adjustment, etc.).

The National Park's management turns its attention to the problem of erosion. It maps processes and damages, and establishes safety measures (Anonymous 2003).


**Fig. 2.5** Examples of human-caused morphodynamic in northern Pirin Mountains: (**a**) hiking trail erosion, (**b**) animal trampling relief in Malkya Kazan Cirque, (**c**) linear erosion and (**d**) mud-stream and debris flow as consequences of ski-run buildings

## 2.3 Water in the Pirin Mountains

Due to the Pirin's abundance of water, it is considered a region of super hydrological importance. Higher precipitation rates and concomitant lower evapotranspiration add up to comparatively high discharges, as the data in Table 2.1 show. Yet, the long-time runoff from the territory of Pirin NP amounts to 356 million m³ per year (Anonymous 2003). The runoff gradient varies between approx. 1,000 mm in higher altitudes and 500 mm in the lower montane belt above the town of Bansko.

Water is of great importance for drinking and industrial use, the production of electric energy and the operation of snow-making equipment for ski slopes. Running off the rivers Mesta and Struma, the water from the mountains is important for ecosystems in northern regions of Greece (Grunewald et al. 2007; Skoulikaris 2008). The water demand increasingly shifts to the winter season, when the amount of runoff and evapotranspiration is marginal.

There are three significant types of subterranean water in the region (cf. Anonymous 1977; Grunewald et al. 1999):

- Flow of groundwater in the shingle of river terraces and floodplains (Struma, Mesta, Istok, Glazne and others)
- Water in crystalline rock ravines of the mountains, and
- Karst water in the northern and southern Pirin Mountains

The Pirin Mountains mark the main water divide, which runs NW–SE according to the main axis of the mountains. The drainage is carried about one half each by Struma and Mesta. The valley and river systems of Banderica and Demyanica are the most important in the northern Pirin.

The Banderica springs from the Banderica Cirque, which bears several lakes. The length of the river amounts to 13 km in an average altitude of 1,900 m a.s.l. The study areas are predominantly situated within the drainage basin, which extends to 37 km² (Hristov and Mitshev 1995). In the upper part, the Banderica flows through a typical trough valley and primarily cuts granites. The marble middle part of its stream course is characterized by a canyon-shaped valley. In the area of the Banderica Polyana (upper station of the cable car), the river partly flows subterraneous. To the southwest of Bansko, the Banderica discharges into Demyanica. Above Bansko the river is tamed, diked and utilized. Numerous streams are drained for irrigation purposes.

From Bansko the river flows in a concreted channel and is called Glazne. To the east of Razlog it joins the Istok, leaves the basin through a meandering narrow valley and finally reaches the Mesta, which springs from the Rila Mountains (Fig. 2.6).

**Table 2.1** Water balance of the Pirin Mountains (1936–2000, acc. Anonymous 2003)

| | Area (km²) | Mean altitude (m a.s.l.) | Precipitation (mm $a^{-1}$) | Evapotranspiration (mm $a^{-1}$) | Runoff (mm $a^{-1}$) |
|---|---|---|---|---|---|
| NP Pirin | 404 | 2,035 | 1,119 | 238 | 881 |
| Pirin Mts. | 2,253 | 1,214 | 749 | 360 | 389 |
| Bulgaria | 110,828 | 506 | 619 | 462 | 157 |


**Fig. 2.6** Map of the Basin of Razlog with river network and flanking mountains

The runoff regime and water supply are regulated by storage in snow and lakes in cold, high altitude areas of the mountains (snow regime). The maximum discharge is in May/June (Anonymous 1977, Grunewald et al. 1999). A high variance of the amounts of precipitation both interannual and within single weather periods is characteristic (see Section 4.1). This can result in relatively long dry periods and in flooding. Smaller water retaining works, mostly between the mountains and basin, ensure a better availability of water. Flood and erosion protection requires improvement.

Field studies conducted between 1998 and 2004 evaluated the water quality of Banderica and Demyanica for saprobity, chemistry and structural values (Grunewald et al. 2007). Generally, the best quality was observed. Only some reaches showed deficits caused by the anthropogenic interference into the stream course and water withdrawal, for example artificial snow making (Banderica), waste water discharges and land use adjacent to the rivers (e.g. areas at the camping ground/kiosk near the Banderica Hut).

In August 2001 (dry weather flow) and June 2002 (humid phase), hydrochemistry and hydrobiology of selected streams in the northern Pirin Mountains were evaluated (Anonymous 2003). The results confirm a very high water quality in the rivers, which almost exclusively can be attributed to the salmonid zone. A continued scientific monitoring on runoff and water constituents has not yet been realized (Grunewald and Schmidt 2001; Anonymous 2003; Grunewald et al. 2007).

Batakliev (1972) counted 160 glacial lakes in the Pirin Mountains (plus 34 intermittent and 110 filled lakes) whereas today there are barely 118 glacial lakes with durable water regime (Anonymous 2003). Approximately one half of the lakes are situated in the cirques within the drainage basins of Demyanica and Banderica in the northeast of the mountains, which were affected the most by the Pleistocene glaciation. This applies to only the parts of the drainage basins in siliceous rock. If there are lakes with episodic water regime, they are in the marble region (cf. Fig. 2.3). In general, the lakes are small and shallow. More than 80% contain a water volume less than 100,000 $m^3$ (Anonymous 1977). The Popovo Esero is the greatest lake with an area of 12.4 ha and it's also the deepest with a 29.5 m depth.

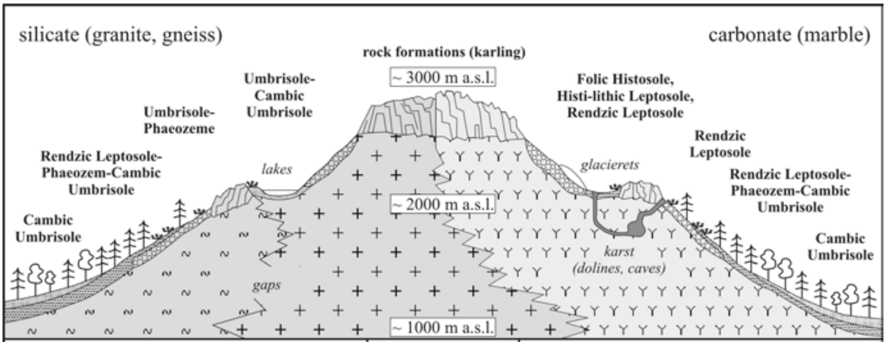
There are current data on physical-chemical and biological parameters (Anonymous 2003, Bahr 2005) for many of the Pirin lakes. Neutral pH-values (6.5–7.5), electrical conductivity less than 30 $\mu S\ cm^{-1}$ and nearly non-detectable nutritional content are characteristic. The trophic level of the cirque lakes can be classified as oligotrophic and ultra oligotrophic (Anonymous 2003). The sedimentation of the examined lakes show different characteristics (Bahr 2005). For instance, Lake Muratovo and Lake Spanopolsko exhibit indications of biogenic fill-up by peat formation and macrophytes, whereas Lake Bezbog, Lake Ribno and Javorov Lake exclusively fill up with sedimentary material. These processes are natural and partly enforced by anthropogenic interferences (cattle breeding, tourism). Compared to the lakes in the Alps, the Pirin lakes are considered less affected and nutrient-poor (Veit 2002).

Vetter (2003) examined climate-driven changes of Lake Königssee near Berchtesgaden in the Alps from 1975 to 2005. The rise in air temperature by 2°C within this 30-year span also became noticeable aquatically. The lake temperature rose by 0.2°C, the stratification extended by approximately 30 days and the epilimnion shifted deeper by 1 m. The lakes in the Pirin Mountains should respond similarly.

## 2.4 Soil and Biosphere

In the northern part of the Pirin Mountains, soils, humus forms and vegetation types, as well as their hypsometric variance, were examined. Five toposequences with more than 70 sites were mapped. In addition to the field designation, pH-value, particle size, humus content, C/N ratio, lime and phosphor content, as well as cation exchange capacity, were determined (Grunewald et al. 2005).

Based on a digital terrain model (DTM) of Southwest Bulgaria, a digitized geological region map and statistical methods, the study sites were classified according to soil




| montane | timberline | subalpine | altitudinal belt | subalpine | timberline | montane |
|---|---|---|---|---|---|---|
| 8 °C | 4 °C | 0 °C | annual temperature | 0 °C | 4 °C | 8 °C |
| 185 days | 155 days | < 100 days | growing season | < 100 days | 155 days | 185 days |
| 50 - 60 days | 160 days | 250 days | annual snow cover | 250 days | 160 days | 50 - 60 days |
| < 1 m | 1 - 2 m | > 2 m | snow quantity | > 2 m | 1 - 2 m | < 1 m |

Layout: Jörg Scheithauer 2007

**Fig. 2.7** Idealized profile across the northern Pirin Mountains

units (Läßiger 2006). The collected data provided a basis for the compilation of a "map of potential soil groups" by regionalization with the help of GIS (Fig. 2.8).

The distribution of soils is closely related to the geological, geomorphologic and climatic properties of the area (Grunewald et al. 2005). Figure 2.7 illustrates the typical sequence in the northern Pirin with an idealized profile. Läßiger (2006) provides detailed descriptions of the map units. Figure 2.8 shows the compiled soil map. According to AG Boden (1996) and WRB (2006), six different soil communities could be identified. The resulting map exhibits a confidence level of 68% on 74.4% of the covered area (Läßiger et al. 2008). Due to the orographic-determined climate gradient and depending on the petrological specification, different pedologically plausible sequences of soil types are found, which locally experience variations by geomorphologic conditions like exposition and inclination.

On calcareous substrate in higher regions, Skeleton soils and Rendzinas tightly interlock (complexed). At higher levels, alpine Lithosols (Folic Histosols, Histi-lithic Leptosols and Rendzic Leptosols) with occasionally thick humus layers are predominant. Rendzinas (Rendzic Leptosols) are superseded by a combination of Rendzinas, Pararendzinas and Cambisols (Rendzic Leptosols-Phaeozems-Cambic Umbrisols) at decreasing altitudes. On silicatic substrates, pedogenesis is more advanced, such that Regosols in combination with Cambisols (Umbrisols-Cambic Umbrisols) can be found at sites with high radiation exposure, even in alpine regions. Cambisols with increasing thickness and browning of the profiles are found at decreasing altitudes. Other than the enhancement of soil development with decreasing altitude, the hypsometric variance manifest as humus content decreases. The influence of substrates becomes evident in both the enhancement of soil development and in the increase of soil acidity (cf. Blume et al. 2002; Matthews 1992;

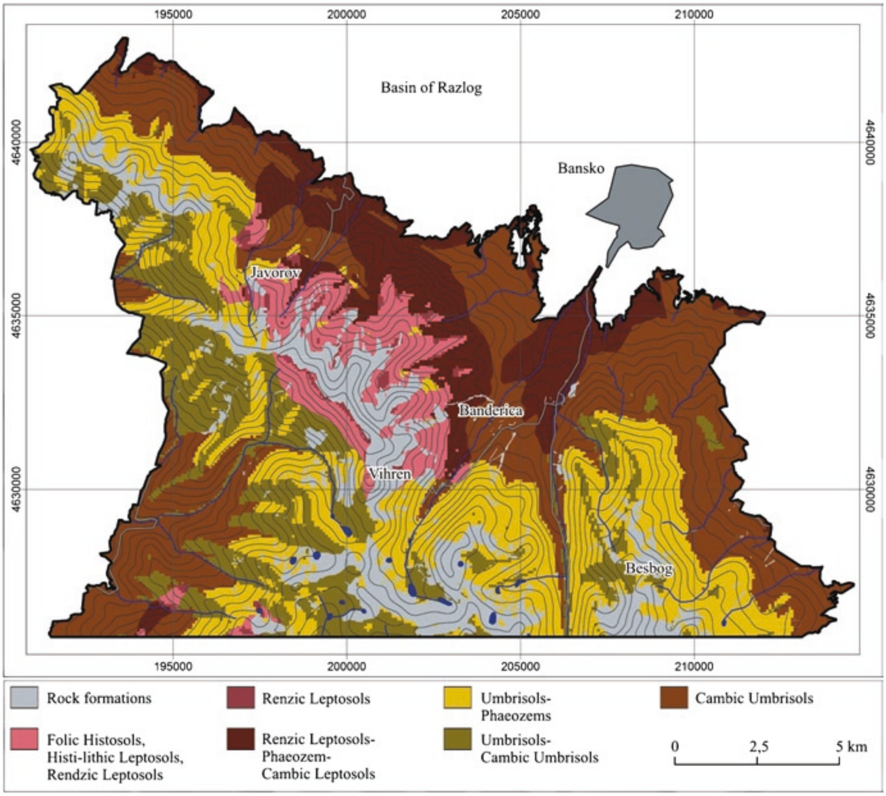



**Fig. 2.8** Map of potential soil groups in the northern High Pirin Mountain (Läßiger et al. 2008)

Sjogersten 2003; Stanton et al. 1994; Stottlemeyr et al. 2001; Veit 2002). Humus types are closely related to vegetation. The occurrence of raw humus is related to coniferous trees, while mull and mould are found at sites with larger radiation exposure and under grass and deciduous trees. Within the chemical parameters the humus content exhibits a hypsometric variation. The corresponding slope is 0.8% per 100 m. On calcareous substrates, the soil reaction is slightly acidic or neutral, whereas on silicatic substrates, the pH-level is strongly acidic. The C- and N-content is with 0.77 closely correlated (progressivity of regression 0.053). The C:N ratio exhibits an average value of 18. Subalpine grass areas at the timberline tend to have a higher proportion of nitrogen and therefore a lower C:N ratio than brown vegetation such as dried leaves under forests, particularly on Cambisols (cf. also Section 4.3).

Pirin National Park is on the intersection of the European, Mediterranean and Pontic biogeographical regions. Vegetation zones and altitudinal levels, as well as vegetation-ecological mappings along an altitudinal transect between Bansko and Golemya Kazan Cirque, is compiled in Grunewald et al. (1999). A comprehensive

**Table 2.2** Pirin National Park – vegetation communities and representative species (acc. Anonymous 2003)

| Community | Representative species |
|---|---|
| Riparian communities | *Heracleum verticillatu, Cirsium appendiculatum*, *Eriophorum latifolium, Cardamine rivularis, Plantago gentianoides*, *Parnassia palustris*, *Saxi-fraga stellaris*, *Silene pusilla*, *Carex nigra, Carex distans, Trichophorum caespitosum*, *Ranunculus aquatilis*, *Sparganium angustifolium, Isoetes Lacustris*, *Subularia aquatica, Cirsium appendiculatum*, *Heracleum verti-cillatum, Doronicum hungaricum*, *Petasites albus*, *Parnassia palustris, Juncus, Petasites kablickianus* |
| Shrub communities of the sub-alpine level | *Pinus mugo*, *Vaccinium*, *Sesleria comosa, Nardus stricta, Sesleria coerulans, Agrostis rupestris*, *Carex curvula*, *Juniperus sibirica, Lerchen-feldia flexuosa, Festuca valida*, *Festuca nigrescens, Sesleria comosa*, *Chamaecytisus absinthioides, Agrostis capillaries*, *Bruckenthalia, Dryas* |
| Grassland communities | *Sesleria comosa, Nardus stricta, Festuca valida, Deschampsia caespitosa, Carex, Festuca nigrescens, Festuca nigrescens, Nardus stricta*, *Agrostis capillaries, Calamagrostis arundinacea* |
| Forest communities | *Pinus nigra, Pinus sylvestris, Pinus peuce, Pinus heldreichii/ Picea abies, Abies alba, Fagus sylvatica, Populus tremula* |
| Rock communities | *Saxifraga*, *Thymus perinicus*, *Papaver degenii*, *Arabis ferdinandi-coburgii, Potentilla appenina* ssp. *Stojanovii*, *Dianthus microlepis, Androsace villosa*, *Rhodax alpestris*, *Silene acaulis* u.a. |
| Secondary communities (anthropogenous) | *Verbascum longifolium* ssp. *Pannosum, Rumex alpinus, Veratrum album*, *Deschamptia caespitosa, Polygonum arenastrum*, *Galeopsis bifida*, *Chenopodium bonus-henricus* |

inventory of the flora and fauna in Pirin National Park was carried out in context with the "Pirin Management Plan 2004–2013" (Anonymous 2003). Popov et al. (2005) present a prevailing and well illustrated monograph on the biotic configuration of the Pirin Mountains.

Due to the specific flora, the Pirin constitutes a separate zone of Bulgaria's vegetation units (Bondev 1991). According to Anonymous (2003), a vegetation classification can be carried out considering the groups shown in Table 2.2.

Including the stands of dwarf mountain pines (*Pinus mugo*), forest covers the largest area of the National Park at 57.3%. Pine stands are dominant. Overall, there is 95% of coniferous forest compared with only 5% of deciduous forest (Anonymous 2003). The forest condition is appraised as good. The distribution of tree species becomes apparent in Figure 2.9.

The Pirin flora is comparatively authentic and autochthonous. Lower plants comprise:

- Aquatic plants: 165 species, one very rare and two endemic
- Lichens: 329 species, three protected
- Fungi: 375 species, six with strict protection requirements
- Mosses: 367 species, 25 rare

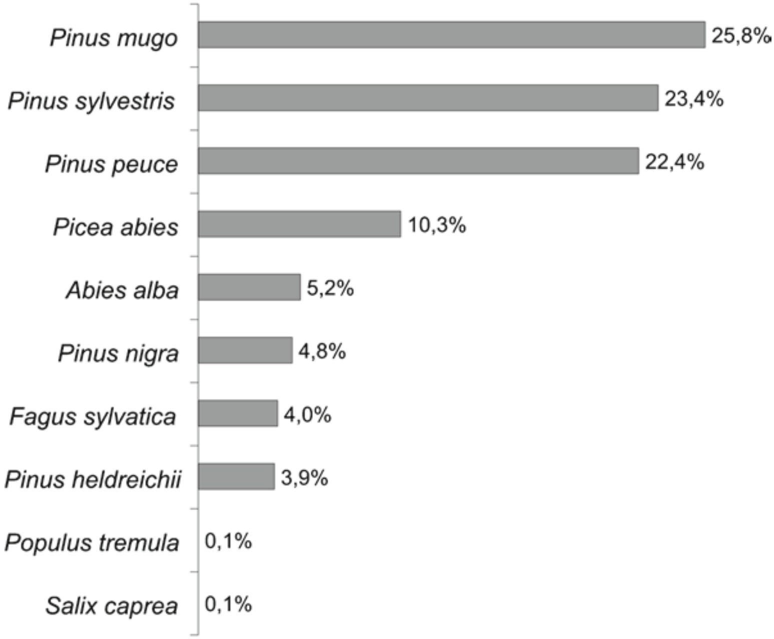



**Fig. 2.9** Tree species distribution at the National Park Pirin (Anonymous 2003, p. 46)

In the National Park there are 149 species among the 1,315 higher plant species with special importance placed on nature conservancy matters. One hundred and fourteen of these species are listed in Bulgaria's Red Book of endangered species, 54 species enjoy protection by law and there are 14 Pirin, 17 Bulgarian and 86 Balkan endemics (Popov et al. 2005). Some plants underlie protection requirements according to international conventions, among others the *Pinus peuce* (Macedonian pine). The National Park's Management Plan presents clear protection and use restrictions for flora and fauna (Anonymous 2003).

The invertebrates amount to 2,091 species, 294 of them are rare, 216 endemics and 176 relics. Typical are spiders (*Araneae*), centipedes (*Myriapoda*), mayflies (*Ephemeroptera*), caddis flies (*Trichoptera*), stoneflies (*Plecoptera*), dragonflies (*Odonata*), true bugs (*Heteroptera*), beetles (*Coleoptera*), net-winged insects (*Neuropterida*), membrane-winged insects (*Hymenoptera*), butterflies (*Lepidoptera*) and molluscs.

Six fish species live in the Pirin Mountains. As a glacial relic, the Balkan trout (*Salmo trutta*) is a species of particular interest. Eight amphibians, 11 reptilian species, 159 bird species and 45 vertebrates are counted in the Pirin. Many of them are under a high protection state due to their biological importance and endangerment status (Anonymous 2003). The wild species brown bear (*Ursus arctos*), grey wolf (*Canis lupus*), European pine marten (*Martes martes*) and the Balkan chamois (*Rupicarpa rupicarpa balcanica*) are examples (Anonymous 2003; Popov et al. 2005).

Although many plants in high mountain ecosystems are able to live a long life – some communities more than 1,000 years – they require relatively little space. However, most animals do not grow as old (30 years on average) but require a larger living space (Nagy et al. 2007). Species respond differently to climate changes and anthropogenic interferences (Erschbamer 2007).

## 2.5 Pirin National Park – Potentials and Anthropogenic Interference

Natural potential determines the pros and cons for human utilization of the landscape and the distribution and intensity of land use, but depends on climate as an ecological control factor (Blümel 2002). In a high mountain region many kinds of land use are limited or impossible. Table 2.3 compiles advantages and disadvantages of the natural setting in Southwest Bulgaria. Basically, they do not differ from other mountainous regions.

In the mountain region Rila-Pirin-Rhodopes forests are predominant, whereas agriculture and settlement areas confine basins and valleys (Grunewald et al. 1999; Grunewald et al. 2007). Due to the resource availability within the northern Pirin study area, four branches became important:

1. The forestry industry: More or less intensive, the timber richness of the montane belt is traditionally used as construction timber and firewood, as well as for furniture construction.
2. Water: Irrigation, drinking water, energy generation and most recently for artificial snow making.
3. Mountain pastures: The Aromanians were residents in the Pirin Mountains; in summer they used the pastures in Pirin and in winter they drove the cattle to the

**Table 2.3** Landscape potential of Southwest Bulgaria (Grunewald and Scheithauer 2007)

| Favorable factors | Disfavorable factors |
|---|---|
| Raw material/mining: iron ore, coal, uranium, marble and other | Location: peripheral, near borderlines, migration area |
| Geothermic/mineral and hot springs | Mountain relief, altitude and climate, impassibility, isolation areas |
| Water: irrigation, hydroenergy, fish | |
| Timber, herbs, mushrooms, berries | Mountain soil conditions: shallow, nutrient-poor, stone-rich, dry/wet |
| Pastures, hunting grounds | Vulnerability: earthquakes, floods, droughts, erosion and other |
| Fertile soils in basins and valleys; cultivation of special vegetation: tobacco, rice, wine and other | |
| Fresh mountain air, bracing climate, landscape scenery, uniqueness and beauty | |
| Biotic refuges | |

plains in the Aegean (Kahl 2003). Since the beginning of the twentieth century, the pasture economy has regressed due to border politics and the displacement of the Aromanians.

4. Tourism: Louis (1928) wrote about the increasing influence that tourism had on the most beautiful and most accessible areas of the Pirin Mountains. Today, tourism is still of enormous importance for the region. Bansko emerges as eastern Europe's number one winter sports resort location. Roads and lifts have made the high-elevation sites accessible to everyone (Grunewald and Scheithauer 2008).

Tourism is also the region's motor for socioeconomic development. The traditional mountain agriculture is regressing. Only half of the pastures' capacities are used. Anonymous (2003) estimated the potential for grazing animals in the mountain regions Bayuvi Dupki, Vihren, Bezbog, Sinanica and Kamenica at 2,954 animal units. From 1997 to 2001, the number of grazing animals amounted to between 1,162 and 1,370. One animal unit refers to one cow with 500 kg of weight and a daily consumption of 60 kg of forage, or five sheep or 0.8 horses.

The economic role model of the Alps serves as a guide for mountain regions in southeastern Europe since the fall of the Iron Curtain. It didn't take long to learn that ski and spa tourists bring in significantly more money than hikers and eco-tourists (Grunewald and Scheithauer 2008). The needs of consumers changed rapidly. Recently, a trend to short break, spa and event sports has emerged. The interdependency between tourism, climate change and natural hazards will be much more in focus.

The tourist industry has the biggest strategic significance on Bansko's social-economic development, as it is the most dynamic and the fastest growing branch of the economy. For the period 2001–2006 investments in tourism totalled over 100 million Euros. This led to more than 500 new employment positions in tourist services and several times more than that in the building sector (Anonymous 2008). In recent years (before the global economic crisis), more than 100 hotels were built, from small family hotels to luxurious four-star complexes. Hotel "Kempinski Grand Arena" is the first five-star hotel in the resort area. The bed facilities increased from 2,000 (2002) to 10,000 (2007) with a goal to reach 20,000 (Anonymous 2003, 2008). The clientele are generally wealthy Bulgarians, Greeks, Russians, Germans and most of all British. The latter are the target group for selling flatlets under the slogan, "Why not Bulgaria" (Bulgarian Property Agents 2008).

This development has changed the settlement structure of Bansko rapidly, increasingly interfering in nature and putting growing pressure on resources. The infrastructure is overloaded and negative ecological effects are obvious. Environmental organizations documented that the development of the mountains was not exercised with the required care (e.g. Za Zemiata 2007). Is a healthy coexistence between the dispersing, intensified tourism industry and the concerns of nature conservancy possible?

The area of the Pirin NP, including two UNESCO-MAB Biosphere Reserves, comprises 40,356 ha, which makes up 22% of the whole Pirin Mountains. In comparison, 25% of the Alp's total area are under protection. The biotic and abiotic potential of protection was outlined in the previous sections. Until 1999 it was a "Peoples' Park" (bulg. "Naroden Park") under the administration of the state ministry of forestry (Grunewald and Stoilov 1998). In 1998, Bulgarians reformed nature conservancy law and categories according to international guidelines. The NP is now under the control of the Ministry of Environment and Water. It holds the highest conservancy status in Bulgaria. The NP is integrated in ecological networks as it is member of the EUROPARC Federation, approved by IUCN and included on the UNESCO world heritage list.

The NP's main objectives are set as follows: Preservation of the (sub) natural and worthwhile landscape; preservation of the region's representative landscape types as well as its flora and fauna. Hence, there are following major tasks:

- Execution and coordination of education and recreation as well as science and research in the NP
- Compilation of a nature management plan for maintenance and development
- Coordination, authorization, assistance and control of the planning and execution of all activities concerning the NP

The enacting of the Management Plan for Pirin National Park 2004 to 2013 is a milestone which could be realized with financial help and the assignment of personnel by Switzerland (Anonymous 2003). The plan includes nature conservancy and landscape development, as well as the use of resources and tourism, so as to provide an integrative review. The NP serves as a socioeconomic factor of regional development and constitutes a binding operational instrument. Modelled on "The Alpine Convention" (1991) the management plan became the basis for sustainable development in the mountain region. It is aimed at guaranteed attractive living conditions. This comprises the intermediation in the conflict between the claims of use and conservancy strategies (Grunewald and Scheithauer 2008).

The touristic use of national parks in Europe is not uncommon. They are zoned to separate areas under strict protection (core zones, reserves) from other areas. Figure 2.10 illustrates that only 3.3% of the total area in Pirin National Park is allotted for tourism use. Insofar as the possibility for exemplary cooperation does exist, Bansko and the National Park may act as a model region for modern nature conservancy and the establishment of sustainable tourism on a local, national and international scale. The realization of the objectives established in the management plan requires time, consistency, support and control. If it fails to constrict the further development of the tourism industry, the protective areas of the Pirin are in danger of deterioration.

The international community is watching whether the region can succeed in combining matters of nature conservancy with tourism. Investors, the local population and tourists should be aware of the vulnerability of sensitive high mountain ecosystems and that the World Heritage List approved the UNESCO-MAB reservations as being not untouchable. The Pirin region could be regarded as a role model for upcoming ski resorts in southeast Europe national park areas (e.g. Rila Mountains) and beyond (e.g. Sotchi/Caucasus).

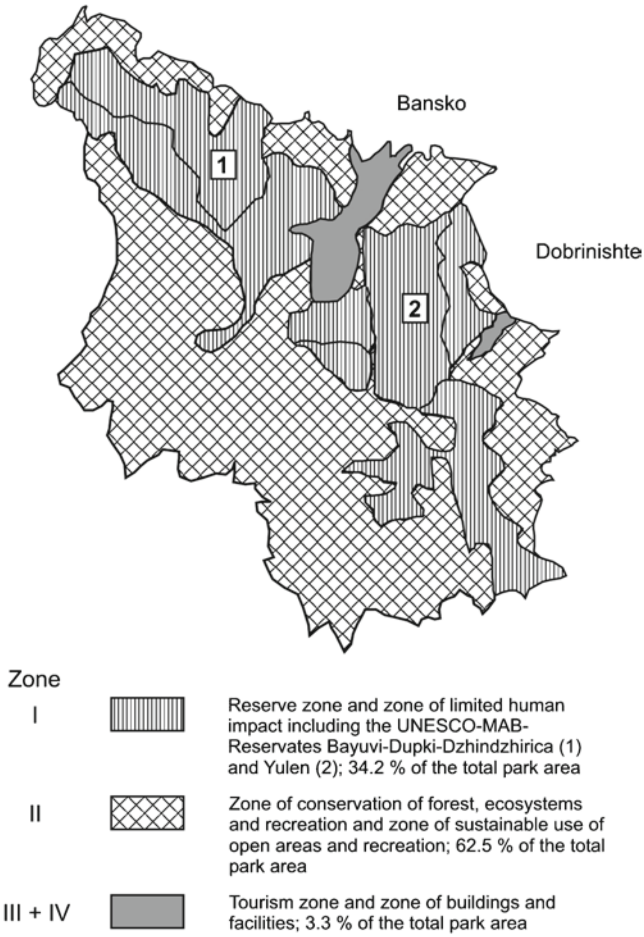



**Fig. 2.10** Pirin National Park – zoning of its territory

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