Chapter 3
Holocene Climate and Landscape Chronology

Abstract The cyclical ups and downs of historic climate conditions and human effects on our area of study can be detected in pollen profiles of peat, glacier features and soils (stratigraphy, macrofossils, charcoal, ^{14}C-dating). This leads to a chronology on a millennium scale. This chapter uses Southwest Bulgaria to demonstrate the relationship between people and their environment in Southeast Europe. It investigates the connection between climate dynamics and the cultural history of the region. Climate is one of the key regulation factors in this regard. Periods of prosperity and periods of crisis that are linked to the climate were detected for the Balkans and can be shown for Southwest Bulgaria as well. Particularly during the Bronze Age, Iron Age, Roman Age, the "Golden Bulgarian Age" and Little Ice Age, the phases of climatic stagnation and transition correlate with stability (soil formation), activity (erosion), and settlement dynamics (expansion versus abandonment).

Keywords Cultural/vegetation history • Geoarchive • Holocene • Palaeoclimate • Pollen analysis • Radiocarbon • Timberline

3.1 Würm Glaciation and Late-Glacial Development

Glacial and periglacial landforms are manifold in the mountains of Southeast Europe. Hughes et al. (2006) identified three phases of development of Quaternary research in this area:

- First, a pioneer phase characterized by initial descriptive observations of glacial landforms.
- Second, a mapping phase whereby the detailed distribution of glacial landforms and sediments have been depicted on geomorphological maps.
- Third, an advanced phase characterized by detailed understanding of the geochronology of glacial sequences using radiometric dating as well as detailed sedimentological and stratigraphical analyses. There is not much of such updated geomorphological research (third phase) on the Balkan Peninsula and in Bulgaria (Kuhlemann et al. 2008, Milivojevič et al. 2008).

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The evidence for glacial and periglacial activities has been studied (first phase) for the Pirin region most notably by Hochstätter (1870), Cvijić (1898, 1909), Penck (1925), Louis (1928, 1930, 1933), Gellert (1932) and Wilhelmy (1935). Most of the following research is based on this initial observation and description of glacial features in the upland landscape, particularly the work of Louis (1930) for the Pirin Mountains.

The second phase, which began in the second half of the twentieth century, was dominated by Bulgarian geomorphologists. Notable exceptions include the work by Glovnia (1958, 1962, 1968), and Popov (1962), and later by Velchev (1995). These authors used relative dating methods with an emphasis on morphographic analyses. Absolute dating and application of modern palaeochronological techniques are only the beginning of glacial-morphology study in Southwest Bulgaria.

The highest mountains of the region (Rila and Pirin) were glaciated on multiple occasions during the Pleistocene. Glacial traces in both massifs show large contrasts between short steep glaciers exposed to the south and long flat glaciers exposed to the north (Louis 1930, Kuhlemann et al. 2008).

Glacial geomorphological records offer evidence of palaeoclimatic conditions in high mountains during the Quaternary in southern Europe (e.g. Cacho et al. 2002, Garcia-Ruiz et al. 2003, Alberti et al. 2004, Woodward et al. 2004, Kuhlemann et al. 2005). Figure 3.1 shows the estimated glacier fluctuations of the cirque Golemya Kazan in the Pirin Mountains. Most extensive phases of glaciation probably occurred during the Mid-Pleistocene (Kuhlemann et al. 2008, Hughes et al. 2007). In Greece, Italy and Spain the glacial deposits of the Mid-Pleistocene age were specified by radiometric dating (Hughes et al. 2006). The glacial succession in Greece was dated by Hughes and others (2006) who applied U-series methods to date secondary carbonates within Pleistocene tills to develop a new regional geochronology and chrono-stratigraphy. This evidence provided the basis for palaeoclimatic reconstructions of different glaciations. Hughes and others (2007) analyzed the lowest mean summer temperatures during 474,000–427,000 a BP (Mid-Pleistocene), which caused the most extensive glaciations recorded in the Mediterranean region. Later Pleistocene glaciations were characterized by higher summer temperatures and higher annual precipitation, resulting in less glaciation (Vlasian stage and Tymphian stage of the Pindus chrono-stratigraphy; cf. Hughes et al. 2007).

In other regions, detailed sedimentological and pedological analyses of glacial and fluvio-glacial sediments are needed to supplement the numerical dating methods, for example, in other Balkan mountains (Milivojevič et al. 2008, Grunewald and Scheithauer 2010).

The Middle Pleistocene glaciers covered an area of ca. 60 km² of the Pirin Mountains. They formed U-shaped valleys and lower-level cirques (Fig. 3.1a). Cirque barriers of 6 to 140 m height show the dimension of glacial forming (Glovnia 1968). The largest glaciers were situated in the Demyanica and Banderica valleys. As opposed to northern Europe and the Alps, the lowland areas of Southwest Bulgaria were characterized by dry and cold steppe during glaciation times. In the Balkans, this is thought to be responsible for genetic diversity and richness of endemic species (Hewitt 1999, Griffiths et al. 2004).

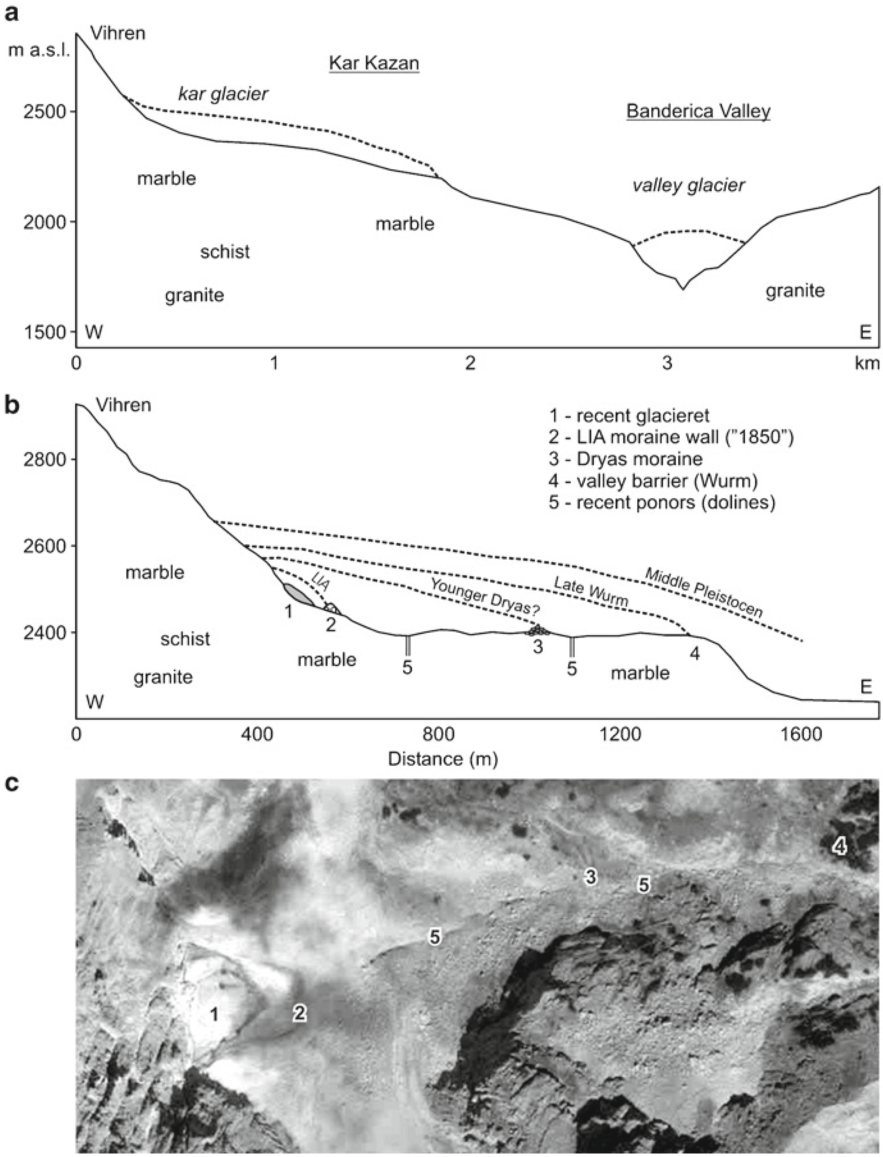

Fig. 3.1 Simplified profile of the glacier positions on a scale of millennia in Golemya Kazan cirque in the northern Pirin Mountains, Bulgaria (**a**) section Vihren – Banderica Valley, (**b**) section of cirque Golemya Kazan, glacier extents estimated according to Popov 1962 and (**c**) satellite imagine of cirque Golemya Kazan with (1) glacieret "Snezhnika" (source: maps.google.de)

The glaciation of the region during the Last Glacial Maximum (LGM ~ 20,000–18,000 ^{14}C BP) reached half of the glacier extension during the Middle Pleistocene (Popov 1962, Kuhlemann et al. 2008). Except for the Pyrenees, the Würm glaciers in southern Europe were limited to a few high altitude cirques (Messerli 1967), which melted relatively quickly. During the late Würm however, fossil, secondary, lobed cirque glaciers and/or rock glaciers must have been situated in cirques such as Golemya Kazan (Fig. 3.1a and b). At lower levels of the northern sides, such as at Malkya Kazan, and at the southern sides, the periglacial solifluidal slope smoothing was the predominating shaping mechanism during Würm Glacial (Höllermann 1983, Schröder and Berkner 1986). Absolute dating has been applied to only one sample from the Rila Mountains, taken in the Musala area from a stadial moraine at 2,390 m a.s.l. (Velchev 1995). The age obtained by thermoluminiscence – 12,000±700 years BP estimates this deposit to probably Younger Dryas depositional age. According to Kuhlemann et al. (2008) the main palaeoclimatic issues unsolved in the Rila and Pirin mountains concern:

- Absolute dating of stadial moraines to follow glacier (and climate) dynamics during the main glacial stages in Late Pleistocene and Early Holocene (Heinrich events, Older Dryas, Younger Dryas, Boreal); and
- Calculation of the equilibrium line altitude (ELA) during the LGM and its patterns within the mountain massif caused by local differences (aspect, location in the mountain) in order to constrain regional atmospheric circulation.

Nevertheless, the initial position of landscape development in Late Würm (15,000 BP) for the higher areas of the Pirin Mountains can be summarized as follows:

- Low mean temperatures (ca. 3–5°C lower than today)
- Glacier/block glacier in north-/northwest exposed cirques above ca. 2,300 m a.s.l.
- Periglacial conditions in the subsequent level

In comparison to the Alps and Northern Europe with large-scale Würm glaciation, the small glaciers of Southeast Europe rapidly reacted to the start of warming. Sufficient habitats as refuge for higher plants and animal species probably existed in ice-free areas of lower mountain belts.

After Würm glaciation, the glaciers of Europe melted relatively rapidly, as the saltation of sediment balance of peripheral alpine lakes documented (Veit 2002). The melt water input from many alpine lakes ended from 13,000–12,400 BP. The decrease of ice and snow left slopes with no vegetation in higher mountain regions, which caused heavy erosion and mass movement. Bozilova et al. (2004) and Stefanova et al. (2003) examined the analogous development for the Pirin lakes. Silty-clayey lake sediments with relative high content of sand without fossil pollen indicate vegetation-free conditions that promote erosion during the first phase of the Late-Glacial (Older Dryas, 15,000–13,000 BP).

The geomorpho-dynamics, vegetation succession and climate variability for the last ~15,000 years can be described with the help of cirque-lake sediments, peat bog profiles and fossil soil developments/charcoal (Grunewald and Scheithauer 2008a). The Pirin Mountains region is well researched in this regard (e.g. Bozilova and Tonkov 2000, Stefanova and Ammann 2003, Stefanova et al. 2006, Tonkov et al. 2002). It is certain that all smaller southern glaciers melted at the optimum climate of the Atlantic Period. The reconstruction of the alpine timberline implies

Table 3.1 Review of the geoarchives lake sediment core, peat bog and fossil soil in higher areas of the Pirin Mountains

Site (m a.s.l.), location see Fig. 3.2	Number of ^{14}C datings		Source
	Late-Glacial	Holocene	
(1) Mozgovica peat (1,800)	–	2	Tonkov (2003)
(2) Lake Ribno Breznizhko (1,963)	–	4	Atanassova and Stefanova (2005)
(3) Lake Banderizhko (2,190)	–	6	Tonkov et al. (2002)
(4) Kremensko-5-Lake (2,114)	6	8	Atanassova and Stefanova (2003) and Stefanova et al. (2006)
(5) Lake Muratovo (2,230)	–	9	Bozilova et al. (2004) and own investigation (2002)
(6) Lake Bezbog (2,250)	4	4	Stefanova et al. (2006)
(7) Lake Dalgoto (2,310)	–	9	Stefanova and Ammann (2003)
(8) Moraine at Golemya Kazan cirque (2,430)	–	4	Own investigation (2005–2007)
(9) Soil profile at Malkya Kazan cirque	–	12	Own investigation (2005–2007)
(10) Soils of marble timberline ecotones above the Banderica Hut (1,950–2,200)	–	6	Own investigation (2005–2007)
(11) Soils of granite timberline ecotones between the Vihren Hut and Spano Pole meadow (1,880–2,430)	–	7	Own investigation (2005–2007)

that the snow line during the Holocene did not significantly change (Grunewald and Scheithauer 2008a).

The phases of vegetation development are well examined, documented and dated (Table 3.1, Figs. 3.3 and 3.4). Palynological studies of Lake Kremensko (Atanassova and Stefanova 2003), Lake Dalgoto (Stefanova and Ammann 2003) and Lake Ribno Banderizhka (Tonkov et al. 2002), as well as of lakes and peat bogs in the Rila and Rhodope Mountains (Bozilova and Tonkov 2000, Huttunen et al. 1992) show that the plant communities of the Late-Glacial period had a very similar taxonomic composition at higher elevations in the mountains of Southwest Bulgaria. Pollen zones correlate with the European biostratigraphic subdivisions on the basis of the calibrated ages (Stefanova et al. 2006).

The core of Lake Kremensko-5, one of the cirque lakes in the northern Pirin Mountains (41°43′N/23°32′E, 2,140 m a.s.l.), contains sediments dating back more than 13,500 years. The radiocarbon dates of the bottom sediments of this lake are the oldest of the Bulgarian mountains and have important implications for the chronology and interpretation of vegetational changes during the interstadial/stadial cycles of the Late-Glacial. Lake Kremensko-5 has more than a meter of Late-Glacial sediments (Atanassova and Stefanova 2003).

The Late-Glacial chronology can be divided into four pollen zones (Atanassova and Stefanova 2003, Stefanova et al. 2006):

1. The initial step in vegetation development began before 13,500 years BP. Cold-resistant species were present. The found pollen herbs suggest the ground covers composition immediately after ice retreat. Wide distributions of open herb communities were dominated by *Artemisia* and *Chenopodiaceae*.
2. Zone 2, dated with 13,350–12,360 BP, also suggests open herb communities of mountain steppe. Increased values of *Ephedera distachiya* type and *E. fragilis* type in the pollen spectra imply drier conditions than during zone 1.
3. After 12,360 BP, the increase of *Pinus diploxylon* indicate warmer conditions leading to the enlargement of coniferous trees in the higher mountain regions. It probably shows the beginning of the Bölling-/Alleröd-Interstadial stage. A distinct change in the type of sediments from grey-green silt to brown silty gyttja was also observed, which suggests increasing productivity in the lake or on the land.
4. In pollen zone 4, the dominance of *Artemisia* and *Chenopodiaceae,* and the occurrence of the *Juniperus-Ephedra* assemblage, indicate increasing aridity and a colder period (Younger Dryas). Mountain steppe species again dominate the areas in 2,000 m a.s.l. elevation, and trees are rare. But the persistence of high levels of *Poaceae* implies that climatic conditions were less severe than before 12,360 years BP.

It is possible to draw the following main conclusions concerning this Late-Glacial environmental and palaeovegetational reconstruction: First, in comparison to the Late-Würm, it became warmer and drier (Oldest Dryas, 15,000–13,000 BP). *Artemisia* and *Chenopodiaceae* predominate, indicating the presence of mountain steppe pioneer vegetation soon after the ice retreat. The morphologic activity increased (erosion, fluvio-glacial debris movement).

From 13,000 BP (or even earlier) temperatures increased once again and humidity probably also rose. An initial increase of organic matter in lake sediments was measured as well (Bozilova und Tonkov 2000, Stefanova et al. 2006, Tonkov et al. 2006). This phase marks the Bölling-/Alleröd-Interstadial, whereas a depression of temperature cannot be explicitly documented for the Older Dryas in the Pirin region. Re-forestation started with migration from the refugial areas in lower elevations. The pollen spectra of investigated cirques were characterized by *Pinus diploxylon* types and macrofossils of *Pinus peuce* and *Juniperus*. Other wind-drifted tree pollen increased (*Quercus, Alnus, Ulmus* and other).

During Younger Dryas (ca. 11,000–10,200 BP) trees again shifted to lower altitudes because of colder conditions. There was a mountain steppe with grass heather and individual dwarf shrubs (*Ephedra, Juniperus*) in altitudes around 2,000 m a.s.l. Palaeolimnological studies of Lake Dalgoto (Stefanova et al. 2003) ensure the described regional climate conditions of Younger Dryas: low water temperature, long ice covering, low productivity and diversity of Diatom. However, the cirque

Dalgoto (ca. 2,300 m a.s.l.) was free of ice during the Younger Dryas period, whereas small debris that covered glaciers and rock glaciers probably existed in a few exposed cirques in high altitudes (ca. 2,400 m a.s.l.) of the northern Pirin (e.g. cirques Golemya Kazan and Banski Suhodol), indicated by moraines of retreat stages, as Fig. 3.1b and c show.

3.2 Climate and Vegetation During the Holocene

Unlike the unknowns in the characteristics of the Late-Glacial period, the Holocene vegetative development in southern Bulgaria's high mountains is comparatively well known and supported by consistent radiocarbon chronologies, as Fig. 3.2 and Table 3.1 show. Lithology and stratigraphy, pollen and plant macrofossil analysis, as well as radiocarbon dating performed on profiles from subalpine lake sediments and peat in the northern Pirin Mountains, enable the reconstruction of vegetation

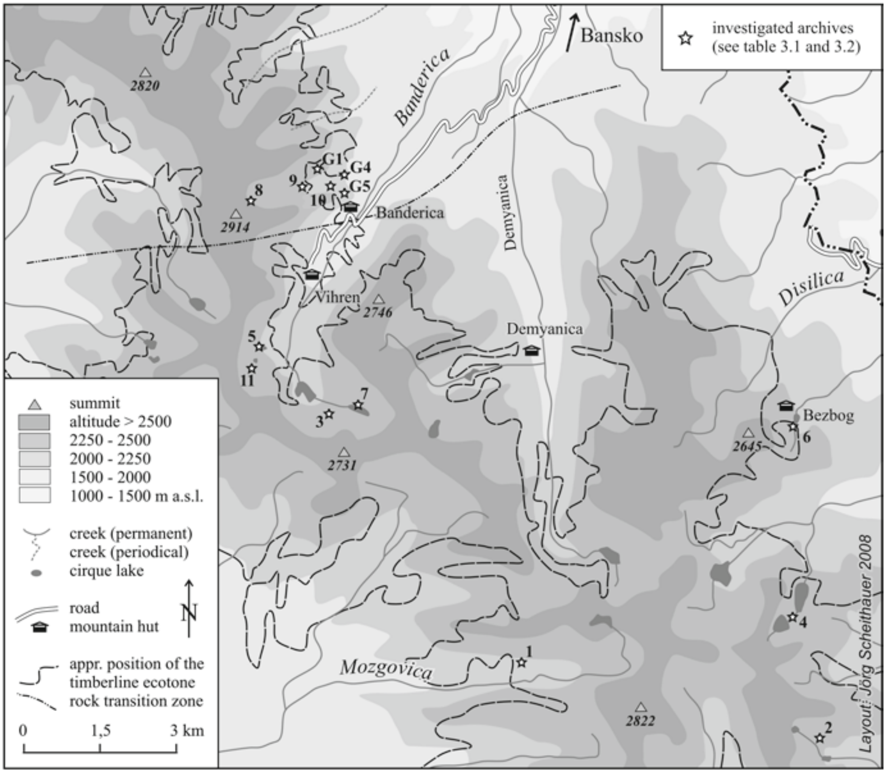

Fig. 3.2 Location of examined geoarchives in the Pirin Mountains (cf. also Table 3.1)

history, climate phases, morphologic dynamics and human pressures (e.g. Stefanova et al. 2006, Tonkov et al. 2006).

The investigation of fossil soils and younger moraines help improve our knowledge of the Holocene landscape history (Grunewald and Scheithauer 2008c). Stratigraphic and dating examination was performed at the moraine of the Vihren glacieret (Grunewald and Scheithauer 2010), at two sites in the cirque Malkya Kazan, at nine sites on marble below the Malkya Kazan cirque barrier and at five sites on granite rocks in the upper Banderica valley. Figure 3.2 shows the location.

In addition to mapping the geomorphological and vegetational properties, the sites were recorded and samples were collected from different horizons. The air-dried fine soil (<2 mm) was investigated with respect to its particle size (sieving), pH-level (electrometric in KCl solution), nitrogen content (N_{org}, acc. to Springer/Klee with Büchi instrument), phosphorous (P_t, photometric acc. Kjeldahl), organic carbon content (C_{org}, wet combustion acc. to Springer/Klee), the elements Fe, Al, Mn and Ca (HNO/HF-extraction, measured by atomic absorption spectrometry), pedogenic iron (Fe(p,) extracted with Dithionit-Citrat acc. Mehra & Jackson, measured by atomic absorption spectrometry), and lime content ($CaCO_3$, with Scheibler). The corresponding methods are described in Barsch et al. (2000) and Schlichting et al. (1995).

Björn Günther, Institute of Forest Use, University of Technologies Dresden, was able to determine existing wood types of sampled available charchoal. More than 70 radiocarbon datings of pollen, macrofossils, charcoal and fine humic sediments/soils, analyzed by different approved-AMS laboratories are available today, as Table 3.1 lists.

Figure 3.3 shows the approximate distribution of forests and how the major trees adapted to ecological conditions at mountain levels. Birch trees quickly reached an altitude of about 1,900 m a.s.l. during the Early Holocene. The so-called Holocene Climatic Optimum was marked by the *Pinus peuce* expansion. The *Pinus peuce* distributed up to 2,300 m a.s.l. during the 7,000–4,000 years BP period. This corresponds well with the maximum rise of the timberline in the Alps and the maximum northern shifting of the polar timberline in Fennoscandia. The Holocene has been a period of

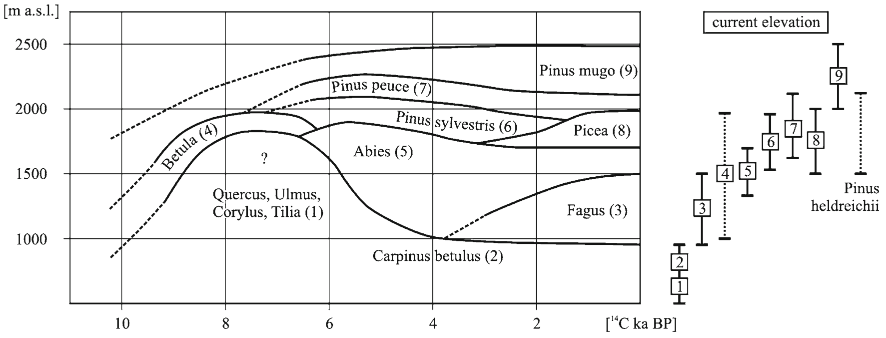

Fig. 3.3 Distribution and elevation gradient of main tree species in the Pirin Mountains during Holocene (according to Stefanova and Ammann 2003, p. 104, modified)

remarkable climatic stability in Europe. During the Holocene, the temperatures varied within a small range of ±2°C (Veit 2002, Solomon et al. 2007).

Climate-ecological changes, different distances to the glacial refuges and long migration times of the species probably caused the expansion of deciduous forests and the late widespreading of *Abies* and especially *Picea* (Grunewald and Scheithauer 2008a). Warm and wet conditions during the early and mid Holocene may have favored the rise of the upper limit of the deciduous tree taxa.

On the millennium timescale, changes in the earth's movements (variations in eccentricity, axial tilt, and precession of the earth's orbit) determined climatic patterns on earth, known as Milankovitch forcing. The distribution of total solar irradiance substantially changed over the course of the last 6,000 years due to changes in the orbital parameters. The largest changes occurred during boreal summer and autumn, when the solar irradiance was progressively reduced in the Northern Hemisphere and enhanced in the Southern Hemisphere. Therefore, the Intertropical Convergence Zone (ITCZ) and the monsoon systems moved south (Wanner et al. 2008). This trend started from ca. 5,500 years BP and was abrupt in some regions, especially in Southeast Europe and the Mediterranean. It is a main reason for the changing dominating tree species in the Pirin Mountains during this time period (Fig. 3.3).

3.2.1 Early Holocene (Preboreal, Boreal)

The Holocene starts with a sharp increase in the tree pollen of *Betula, Quercus*-types, *Corylus, Alnus, Ulmus, Tilia* and *Pinus Diploxylon*-types such as *Pinus peuce,* as Figs. 3.3 and 3.4 show. Accordingly, the amount of cold-resistant, non tree pollen types (*Ephedra, Artemisia, Chenopodiaceae, Poaceae, Achillea, Rumex, Aster*, etc.) decreased (Bozilova and Tonkov 2000). But the diversity of herb types, as seen in the Late-Glacial, continued in the Early Holocene in higher altitudes. Pedogenesis slowly began and vegetation became denser. The lithology of lakes shows increasing proportions of organic matter and algae, whereas minerogenic incorporation into lakes decreased (Stefanova et al. 2003).

The initial stage of afforestation began with the spread of birch (*Betula pendula*) in open forests at middle and higher altitudes. Individual groups of pines (*Pinus mugo, Pinus sylvestris, Pinus peuce*), alder (*Alnus viridis*) and willows (*Salix* ssp.) established themselves (Bozilova und Tonkov 2000). The upper treeline was formed by *Betula pendula* at about 1,900 m a.s.l. during the Early Holocene (Preboreal and Boreal) in the northern Pirin Mountains. An expansion of mesophylous deciduous trees (*Quercus, Tilia, Ulmus, Fraxinus excelsior, Carpinus, Acer* and others) was observed in lower altitudes (Stefanova and Ammann 2003).

Minor but steady quantities of pollen from *Abies-, Fagus-* and *Picea*-types indicate that these mesophylous, moisture-demanding trees survived in environmentally favourable habitats such as deep mountain valleys (Tonkov et al. 2002).

The Preboreal upward expansion of birches and the establishment of new taxa is a response to warmer and more humid climatic and edaphic conditions. The summers

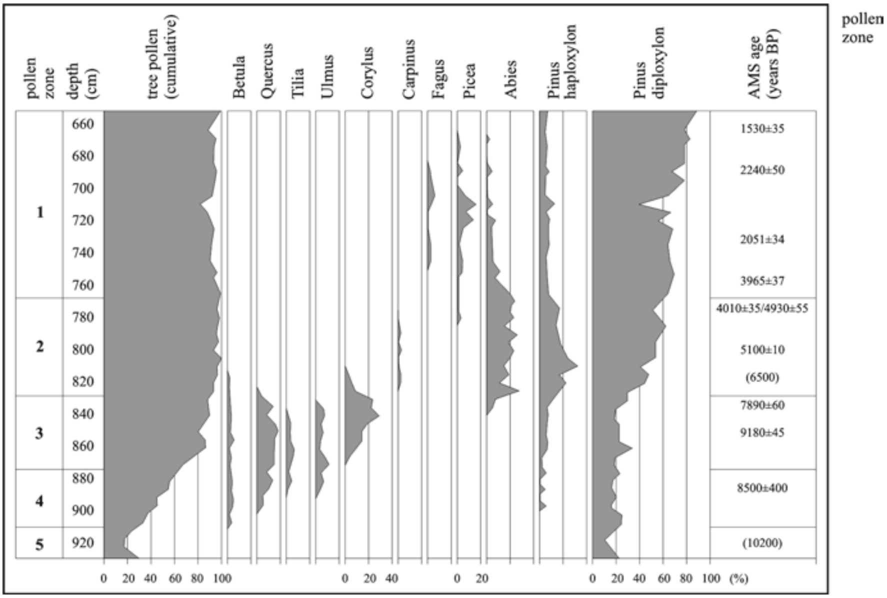

Fig. 3.4 Pollen spectrum of major tree species of the Lake Dalgoto, pollen percentage according to Stefanova and Ammann (2003), cf. Fig. 3.3

became warmer and drier because of high summer insolation (Kutzbach et al. 1993). However, the landscape character of mountain steppe was preserved in higher mountain regions.

The Early Holocene transition between Preboreal and Boreal was marked by a continuing increase of mesophylous deciduous trees. The *Betula* and *Juniperus* distribution decreased (Bozilova and Tonkov 2000, Stefanova and Ammann 2003). Yet only Stefanova et al. (2003) reported clear climatic and biostratigraphic changes regarding the approximate 8,500 years BP period. They detected a clay-gyttja change to Gyttja, increases of *Corylus* pollen and decreases of *Juniperus*, as well as changes in algae and zooplankton in Lake Dalgoto.

3.2.2 *Mid Holocene (Atlantic)*

At the transition between Subboreal – older Atlantic, the change to conifers began in higher regions of the Pirin Mountains (Fig. 3.3). Since 6,500 years BP, a sharp increase of *Pinus Diploxylon* pollen (esp. *Pinus mugo*), *Pinus peuce* and *Abies* pollen was observed in the lake sediments and peats (Stefanova et al. 2006). Conifers superseded birch and other pioneer species, and deciduous trees were forced to grow at lower altitudes. Macrofossils of *Pinus peuce*, *Pinus* ssp. and *Abies* *alba* in 1,900–2,200 m a.s.l. indicate a high level of the alpine timberline and a climatic optimum (Stefanova and Oeggl 1993, Tonkov et al. 2002).

Herbaceous types decreased to about modern values. Mixed oak deciduous forests dominated the belt up to 1,900 m, significantly higher than today. Aquatic conditions also changed after 6,500 BP. The expansion of *Pinus mugo* coincides with signs of natural eutrophication as recorded by an increase of planktonic diatoms (Stefanova et al. 2003). This period was characterized by climate-morphological stability and mountain pedogenesis up to an altitude of 2,300 m a.s.l. in the northern Pirin. Findings of oldest radiocarbon ages of subalpine soils suggest the described environmental conditions, as Fig. 5.3 in Chapter 5 shows.

About 5,000 BP, *Pinus peuce* was established as the dominant tree in the upper part of the coniferous belt and rose above 2,200 m a.s.l. Since 5,000 BP, the abundance of *Pinus peuce* decreased. *Abies* also had its maximum vertical range of distribution between 6,500 and 4,800 BP (Stefanova und Oeggl 1993). These facts indicate a climate-ecological change during the Atlantic epoch. The reason probably was a change of climate seasonality. Cooler summers and warmer winters, characterized by a rise in humidity and precipitation, stimulated this development (Cheddadi et al. 1997, Tonkov et al. 2006). A shift in wind systems and general weather situations could have caused a change of wind-driven pollen and the profile spectra, too.

3.2.3 Late Holocene (Subboreal, Subatlantic)

The late Holocene reconstruction of vegetation and environmental history becomes more detailed because pollen profiles of lake sediments, peat bogs and other archives supply more information.

From 4,000 BP, pollen and macrofossils of *Picea* and *Fagus* increased. The pollen profile of Lake Dalgoto reveals tree and forest development (Fig. 3.4). Spruce (*Picea abies*) started to colonize areas that were dominated by *Abies alba* during the Subboreal – Subatlantic transition at ca. 3,000 BP (Bozilova and Tonkov 2000). *Fagus sylvatica* established itself in lower altitudes. *Picea* and *Pinus peuce* formed the upper treeline, whereas the dwarf pine (*Pinus mugo*) distributed above the treeline (Stefanova and Ammann 2003). According to Tonkov (2003), this development was caused by decreasing average temperatures and increasing precipitation.

Pinus heldreichii dominated at marble sites in higher altitudes. Figure 3.3 does not show the Holocene development of this tree species because its pollen is summarized under the subgenera *Pinus Diploxylon* types (hard pines), and the differentiation from other species of this subgenus is ambiguous (cf. Little and Critchfield 1969). Lakes are almost exclusively located in the silicate area, and macrofossils of Pinus heldreichii were not found in this area.

Anthropogenic activities in the mountain region of Southwest Bulgaria, as well as at the timberline, have increasingly affected changes in the vegetation since 3,000 BP (the end of the Neolithic). Palynogical investigations of human impact in

Southwest Bulgaria have revealed three distinctive periods when anthropogenic activities increased (Bozilova and Tonkov 2000): the Late Eneolithic, the greater part of the Bronze Age and the Iron Age onward. Tonkov (2003), for instance, reported an artificial lowering of the upper treeline and new pasture land in the mountains of Southwest Bulgaria. The occurrence of charcoal particles in profiles correlates well with a rise in the pollen curve of *Juniperus* and other anthropophytes, suggesting the presence of human impact. The native population's basic means of livelihood was animal husbandry, including livestock-grazing in high-mountain pastures.

Since 2,300 ^{14}C years BP charcoal findings in soils increased (see Fig. 5.3 in Chapter 5). This indicates increasing geomorphological activities caused by fires and deforestation. Thus, in connection with climate development, a depression (downward shifting) of the alpine timberline occurred (Fig. 3.3).

Further dating (^{14}C dating of humus and charcoal) of the Vihren glacier moraine (2,430 m a.s.l.) and soil sediments at the cirque Malkya Kazan in the northern Pirin Mountains verifies the soil development intervals and climate-morphological conditions (Grunewald and Scheithauer 2008b).

A moraine at the Sneshnika Glacieret was sampled and examined in September 2005 (Grunewald and Scheithauer 2008c). Dark humus, soil-like components were found in 60 to 240 cm depth in the moraine wall (Fig. 3.5). On the one hand, this is evidence for soil development at this altitude, while on the other hand it shows relocation because such thickness could not be developed in-situ. A *protalus rampart* can be ruled out due to 2 m thick humus material in the moraine. The steepness of the outer wall and two-layered stratification of the front slope is

Layer depth in cm	^{14}C age (AD) clay (%) pH (KCl)	C_{org} (%) N_{org} (%) C/N-ratio	Fe (g kg^{-1}) Mn (g kg^{-1}) Al (g kg^{-1})	Ca (g kg^{-1}) Mg (g kg^{-1}) Na (g kg^{-1})
I 0 60	debris, rocks of marble			
II 60 120	1147-1263 5.5 7.5	1.91 0.07 27.3	10.4 129.5 24.1	272.1 32.9 5.5
III 120 150	332-537 1.8 7.6	2.31 0.18 12.8	9.0 115.8 23.4	277.1 29.4 4.8
IV 150 180	1152-1273 3.4 7.8	2.02 0.06 36.7	6.4 72.7 17.8	313.2 25.1 5.8
V 180 240	428-611 1.6 7.6	2.73 0.14 20.2	7.2 87.1 20.1	291.8 30.4 5.6

Fig. 3.5 Debris-covered moraine of the Snezhnika Glacieret (2,430 m a.s.l., lab-No. of datings: Erl-8743-8746)

characteristic for a rock glacier (rocks on top, finer material underneath; Barsch 1993). The debris underneath the glacieret gravitated in a frozen, ice-rich state towards the wall. The results clearly confirm a moraine because it contains coarse, ungraded, strangled material. The moraine probably marks the size of the glacier at LIA maximum at ~1850 AD in cirque Golemya Kazan (e.g. Grove 2004).

The ^{14}C datings of the humus layers showed two soil-genetic phases of surprisingly younger ages (calibrated ages: 330–610 and 1150–1270 AD). A younger pressure on the wall can be assumed because the four analyzed layers are stored in alternating ages. The chemical-physical results verify the dating of two different age layers (Fig. 3.5). The soil ages determined at the AMS Laboratory in Erlangen refer to the soil organic matter (SOM) of the samples. The SOM should be generated *inter alia* by root material and to a lesser extent by decomposed litter at this altitude. According to Trumbore and Zheng (1996), the SOM age is slightly greater than the ^{14}C age. Although the composition of the SOM was not investigated and the age has to be carefully interpreted, the finding is an indicator of changing climatic conditions.

Warmer periods during Roman times and in early Medieval times might have enabled geomorphological stability and development of plants and soils at ice-free conditions in the range of the present glacieret. When subjected to regular frost, soil genesis stagnates (Eitel 1999) and cryogenic processes dominate. Consequently, the moraine development probably took place under colder conditions between 1270 and ~1850 AD.

The soil profile at the cirque Malkya Kazan is characterized by many humic-boggy layers over melt water-sands (Fig. 3.6). Pasture, deforestation, fires and abundant water events might be the reasons for soil movement and layering. The ^{14}C dating of humus and charcoal at cirque Malkya Kazan support the climate-morphologic determinating soil development intervals.

Basic chemical-physical results of the moraine and soil profile are shown in Figs. 3.5 and 3.6. Particularly the pedogenesis processes of decarbonation, acidification, release of pedogenic oxides and enrichment of phosphates give age indications depending on the altitude (Matthews 1992).

The moraine profile is characterized by a slight alkali soil reaction, a very high content of calcium carbonate, humic contents between 3% and 5% and silty to clayey particle sizes (fraction less 2 mm). The older layers 3 and 5 show nitrogen contents that are twice to three times higher than those of layers 2 and 4. Phosphorous was measured with ca. 250 mg kg^{-1}, clearly under the values that were detected in soil layers of the cirque Malkya Kazan. The element contents also show the relatively small pedogenesis or pedochemical dynamics respectively. High calcium values and low potassium, manganese, zinc and aluminium contents in all examined layers suggest this.

The genesis of pedogenic iron hydro-oxides was obstructed under the climate-morphological conditions at ca. 2,400 m a.s.l. (Fig. 3.5). The values of the cirque soil in 2,200 m a.s.l. (Fig. 3.6) as well as the timberline ecotones soils (Table 4.13) clearly show advanced pedogenesis.

depht (cm)	clay (%)	pH (KCl)	$CaCO_3$ (%)	C_{org} (%)	N_{org} (%)	P_t (mg/kg)	Fe(p) (g/kg)	Ca (g/kg)	Mn (g/kg)	Al (g/kg)	^{14}C BP
0-30	5.7	5.5	5.2	7.3	0.6	---	17.7	15	1164	83	5206
45-50	2.4	7.0	17.2	6.2	0.5	1812	16.6	49	645	48	613
69-77	2.9	7.0	13.6	6.4	0.5	---	14.2	45	854	73	1122
83-87	14.1	7.1	40.6	3.3	0.3	---	14.9	103	589	57	1161
87-107	2.7	7.0	6.8	9.7	0.8	1927	16.6	31	967	75	1132
107-116	2.2	6.9	11.0	9.2	0.7	---	16.1	34	1032	82	1155
116-127	1.6	6.9	4.5	8.2	0.7	---	15.8	34	1052	81	1471
127-142	3.1	7.0	5.2	7.0	0.6	2326	16.4	16	421	90	1276
158-240	0.5	7.6	46.0	---	---	250	1.0	143	42	12	---

Fig. 3.6 Soil profile at the cirque Malkya Kazan with charcoal in many layers (2,200 m a.s.l.); lab-number of dating Erl-8736-8742; not all layers represented in the table; – not examined)

The moraine of the cirque Golemya Kazan in 2,400 m a.s.l. did not contain any charcoal. This indicates treeless conditions. The layers were full of charcoal a cirque step lower in 2,200 m a.s.l. The timber was analyzed. Thin sections for light microscope and recordings of charcoal by scanning electron microscope were performed. By means of anatomical features, the tree species *Pinus mugo* was solely detected. So far there has been no indication as to other trees of the timberline such as *Pinus heldreichii*.

Below the Malkya Kazan cirque, charcoal of shallow humus rich skeleton soils were sampled and dated (Table 3.2). Convex areas are characterized by debris areal, rocks or older moraines. Wet depressions with big humic accumulations are found in concave areas. The ^{14}C age dating shows two building periods: an older one between 2,000 and 3,000 years BP and a younger one at 80–320 BP.

Table 3.2 Characterization of the investigated sites on marble (Oe1–Oe8, timberline ecotones below the cirque Malkya Kazan) and on silicatic substrates (Boe1 to Boe3 and Spa1/Do1, location see Fig. 3.2 No. 10 and 11)

	^{14}C Dating		Short characteristic
Site (elevation m a.s.l.)	Lab-No.	Age BP	(Dating material: CC = charcoal, OM = organic matter, depth)
Oe1 (2,206)	Erl-10444	2,318 ± 52	Small and wet hollow, 10°-inclination, slope, mountain pine, grass, NE-exposition (CC, 10–40 cm)
Oe2 (2207)	Erl-10445	79 ± 44	dry, east-exposed slope with mountain pines and debris of marble (CC, 10–25 cm)
Oe3 (2,194)	Erl-10446	2,973 ± 51	SE-exposure, trampling relief, shallow soil (CC, 10–20 cm)
Oe4 (2,166)	Erl-10447	190 ± 44	Upper steep area of a gully/block debris, garland soils, little charcoal, skeleton-humus-soils, 15°-inclination, SE-exposure (CC, 5–40 cm)
Oe5 (2,124)	Erl-10448	317 ± 45	Rock debris, humus rich, 8–10°-inclination, timber founds (CC, 30–45 cm)
Oe8 (1,950)	Erl-10449	2,028 ± 50	Below of an avalanche talus, juniper-raspberry-meadow, wet, at the foot of opposite slope, N-exposure, 6°-inclination, (CC, 50–65 cm)
Spa1 (2,428)	Erl-11625	3,245 ± 47	Skeleton-humus-soil, subalpine grassland, garland soils, no charcoal (OM, 30–40 cm)
Do1 (2,325)	a-Erl-11626 b-Erl-11627	2,597 ± 45 1,645 ± 44	Layered sands at the siltation area of “Dual Lake”, little charcoal (a-CC 20–50 cm; b-OM 40–60 cm)
Boe1 (2,250)	a-Erl-10440 b-Erl-10441	4,385 ± 54 4,340 ± 54	Slope moved humic material with charcoal on culm granite, below the end moraine at the Lake Ribno, individual mountain pines, animal faecal (horse, cow) (a-CC 20–50 cm; b-CC 50–60 cm)
Boe2 (1,980)	Erl-10442	6,013 ± 58	Boggy site with charcoal on culm granite above the Vihren-hut, grasses, mountain pines (CC 40–50 cm)
Boe3 (1,880)	Erl-10443	2,225 ± 51	Shallow soil on the sidelines of the Block debris talus on granite, below the Vihren-hut, dry grasses, mountain pines (CC 0–40 cm)

Five sites on silicate substrates were examined at the upper, relatively strong anthropogenic-affected Banderica Valley. Table 3.2 summarizes the site characteristic. In comparison to the soils on marble rocks, the locations were wetter as well as richer in humus and clay. The soil reaction was acidic and the C/N-ratio some wider. Ages of charcoal or SOM are notably older than in profiles of marble sites. These findings give important indications, but the derivation of geomorphological phases of stability and activity, or climate conditions, is more or less unsure.

3.3 Outline of Cultural-Historical Dynamics

3.3.1 Würm Glaciation

At the climax of Würm Drift, approx. 20,000 years ago, the snow limit was located between 2,000 and 2,300 m a.s.l., and high mountains were characterized by impressive valley glaciers (Louis 1930). Cirques and cirque lakes, U-shaped valleys and moraines are evidence of these glacial activities. Due to increasing warming, glaciers melted and shaped characteristic landscapes such as glacial-fluvial talus fans at the bottom of the mountains as well as sediments along the runoff paths.

The amount and extent of the material indicate tremendous forces and the dimension of deglaciation processes. Despite the initial warming, conditions in the mountainous regions were still inhospitable. Tundra vegetation was predominating as well as cold snaps and geomorphologic instability. Late-Glacial hunting cultures appeared not before the Younger Dryas (11,000–10,200 BP) and adapted to the new environmental conditions. A global warm period followed the Late-Glacial cold snap almost immediately. Approximately 10,200 BP the last cold stage was definitely over and the so-called postglacial climatical optimum followed (Blümel 2002).

3.3.2 Boreal and Atlantikum (10,200–4,800 BP)

A rather long and stable period during the Boreal and Atlantikum marked the beginning of essential cultural-historical developments. Temperatures were 2°C warmer than today (Blümel 2002). Forests spread out and psychrophil species were displaced as glacial relics into higher mountain regions.

Humans became sedentary in basins and valleys. Southwest Bulgaria is situated near the Fertile Crescent (Palestine, Lebanon, Syria, Mesopotamia, Turkey, Persia), where the Neolithic Revolution took place approx. 7,000 BC. A culture of nomadic hunter-gatherers turned into a society based on agriculture and animal breeding. This way of living also spread to ecologically favored regions in Southeast Europe due to immigration or expansive diffusion. The climate during the Atlantikum was mild with warm summers and reliable atmospheric conditions, and hence, was a main factor in high agricultural output and the development of neolithic cultures in Europe. Areas with fertile soils had an advantage. This applied only to the basin and valley areas in Southwest Bulgaria.

In the Thracian plain (Marica Valley) and elsewhere, settlements were established around 6,000 BC (Renfrew 1980). Grave and settlement mounds, as well as evidence that farmers (probably Thracians) led a stable life (wheat and barley cultivation, storage in clay pots, baking ovens), indicate a high level of development

(Marinova et al. 2002). Since 5000 BC, metals such as copper and gold could be melted. In this regard, the archaeological excavations are ongoing and should reveal more information (Williams 2007).

3.3.3 Bronze Age and Ice Age

Climate conditions in Europe deteriorated again during the Bronze Age (3,000–2,600 BP), as, for instance, revealed by studies on the death of the glacier body "Ötzi" 3,000 years ago. The annual mean temperature was between 1°C and 2°C lower than today. Consequently, we can assume that cultural-historical development stagnated in many parts of Europe (Blümel 2002).

The following Ice Age is considered a period of change and transition for Southeast Europe. Thracian tribes probably evolved their culture. They cultivated wine, which indicates a favorable climate. There is also evidence for settlement formations (Belov 2005).

The Thracians as feared warriors were involved in the Trojan War against Greece (1,200 BC) and in the campaigns of Alexander the Great in the fourth century BC (Williams 2007). Heredot described the Thracians as a grand nation of people having a large and strong physique (Dimitrov 1966, Weithmann 2000). Such a description implies that they had a good diet.

The further trend of climate development was characterized by a cyclical rise and fall of temperature over several hundred years, without extreme amplitudes.

3.3.4 Roman Empire (2,300–1,600 BP)

The spread of the Roman Empire can be partly explained by a favorable climate. Mean temperatures in Europe during the Older Subatlantikum were 1–1.5°C warmer than today. Therefore, various mountain passes remained accessible in winter (e.g. the Imperator Trayan's Balkans passage over the Troyan-Pass, Härtel and Schönfeld 1998). As during the Neolithic period, the basins and river valleys were the preferred settlement areas (Fig. 3.7a).

Macedonia became a Roman province (Eastern Province) around 148 BC, although a Greek influence remained (Weithmann 2000). The infrastructural advances by the Romans (especially land transport infrastructure, bases and fortresses) were noteworthy, and facilitated transport, trade and migration. Southwest Bulgaria's ancient cultural landscape with Thracian, Greek, Macedonian and Roman influences strove to its peak. However, Thracian and Macedonian slaves were transported to Rome. The Thracian Spartacus from the region of Sandanski organized the slave revolt in Rome 73/71 BC.

City foundations are evidence of efficient agriculture and trade. Many ancient sites in Southwest Bulgaria, for example, those, near Melnik, Sandanski, Razlog

Fig. 3.7 Selected evidence of the cultural-historic development in Southwest Bulgaria: (**a**) remains of the roman town Nikopolis ad Nestrum (106 AD) near Gotse Delchev, (**b**) view from the early-medieval fortress Momina Kula to the Mesta valley, (**c**) the church of Dobarsko, probably eleventh century – one of the oldest preserved churches of the region, (**d**) evidence of the structural recovery during nineteenth century in Bansko, (**e**) steppization, devastation and erosion problems as a result of non-sustainable usage and (**f**) the new sewage treatment plant in the foreground and behind it the old paper factory "Pirin-hart" from the socialist era in the Basin of Razlog

and Gotse Delchev, show that the valleys in the mountainous regions of Southeast Europe were included in this development. In Roman times, the territories of present Bulgaria were also considered Rome's sanatorium because of the numerous mineral springs (Teodossieva 2004, Grunewald and Scheithauer 2007).

3.3.5 The Migration Period (Fourth–Sixth Century)

Between the fourth and sixth century, climate conditions worsened again in many parts of Europe. It became colder and more unsettled. In the mountains, glaciers expanded and the timberline shifted downwards (Veit 2002). Willows supplied less food and there were crop shortfalls in the agricultural areas. There are reports of droughts during 300–400 AD (Blümel 2002). All of these conditions led to hunger and economic-social insecurity. The Roman road became dilapidated and trade was partially disrupted. Displacement of people and migration were intimately connected with climate. Germanics, Sarmatians, Goths, Eurasian Avars and other tribes crossed the territory of the present Bulgaria. They destroyed the ancient cultures and therefore brought the antiquity to an end. Particularly, Slavs and so-called Old Bulgarians became sedentary. They held their ground in the forests and swamplands as they were skilled hunters, fishermen, beekeepers and artisans (Grunewald and Stoilov 1998). “People displacement” and “migration benefit” are attributed to the described changing climate conditions in Bulgaria.

According to Härtel and Schönfeld (1998), the religious beliefs of the Slavs at that time were characterized by a kind of monotheism. The hurling lightning Perun was considered the chief god (godfather of the Pirin Mountains). Mountains, forests, rivers and lakes were inhabited by the spirits of nature. In many places, these traditions live on today. They show the people’s dependence on, and awe of, the forces of nature. Changing climate conditions and land use through deforestation can be shown by using, for example, geomorphological and soil formation intervals (e.g. Grunewald and Scheithauer 2007).

3.3.6 The Golden Bulgarian Period (Seventh–Eleventh Century)

The First Bulgarian Empire was founded in 681 and was mainly feudalistic (Paskalevski 2006). Its borders ranged from the Black Sea to the Aegean, from the Adriatic to the Tisza and the Carpathians in the ninth–tenth century. The Slavic language and script were developed, laws were enacted, Christianity manifested itself and a Bulgarian church structure evolved, especially in the ninth century (Döpmann 2006). Starting in the eighth century, a symbiosis of Slavic (language), Greek Orthodox (church, tradition) and Thracian elements emerged (Weithmann 1995).

During this time, the expansion of the pre-industrial cultural landscape - forests, meadows, fields, villages, roads and mining - was completed. This development could only occur under warm, stable climate conditions. It does not mean that there were no regressions and periods of crisis, characterized by wars, changing rulers, natural disasters and famine.

Building activity (residential buildings, palaces, fortresses, churches, bridges), visual arts and literature experienced a boom (Döpmann 1973). Vegetation was more and more degraded near the settlement areas (logging, deforestation); herdsmen with sheep and goats were seen over a long distance. People began to keep the cattle in stables throughout the year and the stocks were increased. As a result, more fertilizer was available and the grain yields increased. The open land considerably increased in Southwest Bulgaria, especially in the basin regions. The erosion caused major problems (see Fig. 3.7e). The forests were characterized by strong multiple use: pasture, firewood and timber extraction, collections of leaf litter, poll (German: Schneiteln), charcoal etc. The wet depressions and suitable mountain sites were reserved to meadows and pastures (Grunewald and Stoilov 1998).

3.3.7 Medieval Warmth Optimum (1000–1230) – Also in Bulgaria?

European temperatures increased in the early Middle Ages. This led to a cultural boom, which Bulgaria had experienced a few centuries prior. In central and western Europe, the borders grew 200 m higher, the forest was greatly reduced (in Germany to below 20%, see Bork et al. 1998); accordingly cropland and pastures increased. Agricultural production could supply a growing population, so a surplus was obtained. Trade and industry flourished. Settlements were established everywhere and construction began. Architecture and art from the period reflect the population's vitality, creativity and productivity. But the high goal of the western and central European guilds to build, for example, beautiful "cathedrals into the sky" was not achieved in Southeast Europe. Bulgaria came under Byzantine rule from 1018 to 1185 – a peaceless time with numerous ravages (Härtel and Schönfeld 1998). However, basic life conditions did not change. The property of churches and monasteries even expanded. The Athos monasteries got control over the fertile valleys of the Struma and the Vardar. Some nobles increased their estates; they enjoyed immunity rights and built fortresses. At the end of the twelfth century, principalities emerged in Bulgaria that were de facto independent from the central government (Döpmann 1973).

Regional Bulgarian rulers installed a "Second Bulgarian Empire" from 1187 to 1396 that became, again, a determining power in the Balkans. However, the country did not rest. Feudal feuds, separatist tendencies of the boyars, tax burdens, wars, natural disasters, famine and epidemics, and perhaps climatic amplitudes all weakened rulers and people. Unrest, riots and gangs of robbers were characteristic. Free farmers who wanted to escape bondage and serfdom fled into the mountains (Härtel and Schönfeld 1998).

However, there was a second heyday in early Medieval Bulgaria. Feudal structures were further expanded. Taxes, the introduction of money, duties and compulsory labor reflect this. Little of the architectural and cultural achievements of this period have been preserved. Turkish power, wars, earthquakes and fires have destroyed most of it.

This era is relatively well documented in Southwest Bulgaria. The famous Rila Monastery was founded and gained high spiritual and temporal influence. Twenty villages belonged to the Rila Monastery in the thirteenth–fourteenth centuries (Döpmann 1973). Church buildings from this period are preserved in Dobarsko in the basin of Razlog (Fig. 3.7c) or in fragments in Melnik. Construction and settlement activity is known to have occurred in Mechomya (now Razlog), Bansko, Nevrokop (now Gotse Delchev) and Melnik. Typical were early medieval fortifications at strategic points, often in a location that was difficult to reach. Zvetkov (1981) has documented those for the valleys of the Struma and Mesta. Melnik's prime in the twefth–thirteenth centuries is an example. The despot Alexej Slaw, a nobleman, governed from Melnik to the Rhodope Mountains. From the income, he developed Melnik to an important regional center with fortresses, churches, the Rose Monastery, art and culture (Zvetkov 1979, Härtel and Schönfeld 1998).

The mountain agriculture was as follows:

- Grain could obtain only marginal importance due to the physical-geographical situation.
- Technical crops such as flax, cannabis, cotton, poppy, sesame, and later sunflower, peanuts, lavender and tobacco grew in basins and valleys.
- Fruit (apples, pears, plums, cherries, nuts, figs, peaches, almonds, pomegranates) and vegetables (onions, garlic, tomatoes, cucumbers, Chile peppers, red peppers, potatoes, cabbage, lentils, pumpkins, zucchini, beetroot etc.) were cultivated in gardens. Immigrants introduced many fruits and vegetables.
- Most families kept animals such as horses, donkeys, oxen, cows, chickens, sheep and goats (Hadzinikolov et al. 1980).

Nomadic pastoralism in Southeast Europe was operated by the Aromanians. In particular, the Aromanians moved their sheep and goat herds to high mountain pastures in summer and moved them to snow-free pastures in the plains and coastal regions in winter (Kahl 1999). Since the early Middle Ages, the region's climatic characteristics in the transition zone – from temperate to Mediterranean – has been maintained. The mountain areas were hardly inhabited or grazed in winter. In the southern basins and coastal plains, mild winters without snow were typical. Pastures withered in lower southern locations in summer, while the wetter and cooler mountain pastures were used. The Bulgarians also moved their cattle to the mountains but used and irrigated their pastures and gardens at the sides of basins and valleys.

We can conclude that the period from the first until the end of the second Bulgarian Empire (Seventh–fourteenth century) was a time of complex living with conditions equal to the West (Härtel and Schönfeld 1998). This period abruptly ended with when the Ottomans took over the Balkans.

3.3.8 Contemporary Climate Pessimum (1330; Particularly 1550–1850): The "Little Ice Age"

With the beginning of the fourteenth century, Europe's climate became cold and unsettled. There was considerable glacial expansion and the timberline lowered in the high mountains. This had several implications for Bulgaria. A united army of Poland, Hungary and Transylvania did not come over the Balkans in October 1443 because of harsh winter conditions (Stara Planina, Härtel and Schönfeld 1998). There are reports of "thick snow and long winters" at the beginning of the nineteenth century in Meyers Lexicon of 1871 (cited in Comati and Vlahova-Ruykova 2003, p. 156) and in Kanitz (Volume I/p. 80 and Volume II, p. 119, Kanitz 1882) who reported snow patches in summer in the Stara Planina. According to historical records, the Danube froze more often in the Bulgarian-Romanian part (Weithmann 2000, Comati and Vlahova-Ruykova 2003).

This temperature trend has been overshadowed by more extreme events:

- Floods: In Central Europe especially in 1313, 1319 and 1342, whereas the latter flood reached torrential proportions and caused half of the erosion damage of the last 2,000 years (Bork et al. 1998). Flooding along the Danube is known to have occurred in 1342, 1490, 1501, 1572, 1595, 1598, 1670, 1682 and 1787 (Weithmann 2000).
- Volcanic eruptions with global-regional consequences: for instance, the eruption of the Tambora in April 1815, which was deemed responsible for the following "year without a summer" in many parts of the world (De Boer and Sanders 2004).
- Epidemics: the plague in Sofia in 1340–1342 (Kanitz 1882, Volume II/p. 207), in different parts of the region in 1348, 1416 and 1447 (Weithmann 2000) and in Gotse Delchev in 1834 (Penkov and Dojkov 1998).

The deteriorating environmental conditions had an impact on the vitality of the population, which shrunk by 40% (Blümel 2002, Weithmann 2000). In many places, a regression of civilization evidenced by superstition and witchcraft persecution was observed. Crop failure due to cold and wet summers and extreme season peculiarities became more frequent. Grain badly ripened, harvest rotted and mildew or fungus affected the harvest. Agricultural crises led to deserted villages in central Europe (Bork et al. 1998). Blümel (2002) marks the height of unfavorable weather conditions as between 1680 and 1700. However, there were also some very warm years, revealing wide climate variability, which posed a great production risk.

Many researchers postulate that the described conditions weakened the Bulgarian and Byzantine powers in Southeast Europe and facilitated the Ottoman invasion. The 500-year-long Turkish domination strongly influenced Bulgaria, but the country never lost its identity.

What was the cultural development of the region between the fourteenth and twentieth century, during the Modern Times Era the Turkish feudal system replaced the Bulgarian feudal system. People who were ruled by the Ottomans were considered sojourners, a status that meant extensive freedom of religion (partly toleration for money) and some preservation of cultural identity (Matuz 2005). The power and strength of the Ottoman Empire were based on two pillars: a centralized administration and strict military order. The Ottoman organization initially showed signs of being a caring welfare state (Weithmann 1995). The system worked relatively well until the end of the sixteenth century. Islamization campaigns occurred later. For example, the population of several villages in the Rhodopes, in the Mesta Valley, had to convert to Islam in 1657 (Papadimitriou 2003). The Islamized Bulgarians, the so-called Pomaks, still live in great numbers there.

At that time, however, the disadvantages of orthodox-Islamic ideologies that inhibited the development of productive forces were already evident. There was a shortage of engineers and architects. Art and science could hardly develop. The urban settlements were more spacious than before and their character was determined by mosques and minarets. There was no municipal law. Settlement development, trade, infrastructure and the like lagged that of Western Europe. Forts and roads decayed. Education was frowned upon and remained reserved for the Bulgarian monastery cells. Experiences, skills and knowledge were rarely passed on as there were no textbooks and illustrations were not allowed (Matuz 2005).

Southeast Europe missed the "connection to progress" as there was no individuality or enlightenment (Wagner 2003). An urban or bourgeois class had not emerged among the Balkan nations, with the exception of Greece. Agriculture stagnated. People usually grew only what they needed for survival (Weithmann 1995).

It was a time of strong demographic change: On the one hand, there was a superimposition by the Turks and other nationalities. On the other hand, the population was decimated by plague and other epidemics, and refugee movements from village to city or into mountainous regions were reported. Remote mountain villages in Southwest Bulgaria often remained Bulgarian. These villages became refuges of ethnic and cultural traditions and "hearths" of resistance (Hadzinikolov et al. 1980). There was freedom but life was difficult.

The Ottoman Empire declined in the seventeenth–eighteenth century and the central government weakened ("the sick man at the Bospurus"). The influence from Western and Central Europe increased. There were changes in ownership of land (sales) and various reforms were adopted. In the 1830s, the fief was abolished so that taxes had to be paid directly to the state (Hadzinikolov et al. 1980). Church reforms and the land law of 1867 followed. Christian churches could be built again in Bulgaria in the nineteenth century (there were five churches in and near Razlog), massive houses were built and urban life was stimulated (for example, in Bansko, see Fig. 3.7d, Gotse Delchev and Melnik). The time of the "National Renaissance of Bulgaria" was heralded (Weithmann 1995).

3.3.9 Contemporary Thermal Optimum (Since 1850)

A warmer period is recorded starting around 1850. In almost all the high mountains, moraine walls mark the "peak of the Little Ice Age" at ca. 1850 and thus the start of the younger, naturally caused climate fluctuation (Blümel 2002, see also Sections 3.2 and 4.2). For the twentieth century Sharov et al. (2000) differentiated cold periods in the first decade, in 1940–1944 and 1968–1985 and warm periods in 1910–1940, 1944–1968 and since the mid-1980s. The years 1990–1994 were characterized by unusually warm summers and dry winters.

The temperature and precipitation levels have been cyclic in Bulgaria in the last century (see Section 4.1). Since the 1990s, the so-called man-made greenhouse effect becomes more apparent, i.e. rapid temperature increase and climate change due to burning of fossil fuels (carbon dioxide emissions), deforestation, industrialisation, population increases, and so on.

The years 1877–1878 are of historical importance for Bulgaria because the country achieved its liberation with the help of Russian troops and established an independent principality. Southwest Bulgaria was part of Eastern Rumelia and merged with the Principality of Bulgaria in 1885. The Turkish influence, however, remained until the beginning of the twentieth century. New migration movements were recorded and there was a redistribution of land ownership. Bulgaria became a country of small farmers. An economic boom began. First factories were built, a national currency was introduced in 1880, the administration was established and infrastructural measures could be taken (Härtel and Schönfeld 1998).

The inner-Macedonian and Bulgarian-Greek borderline in 1912, instituted after the Balkan wars, led to the decline of the traditional transhumance (seasonal movement) and the Aromanians (Kahl 2001). Today, the pastures in the Pirin Mountains and other mountains are hardly used by livestock. Many border towns in Southwest Bulgaria suffered a huge loss of importance and population (Melnik and Gotse Delchev). The towns of Blagoevgrad, Sandanski, Melnik, Petrich, Gotse Delchev, Razlog and Bansko received official city status in 1912. Settlements with rural character such as Simitli, Kresna, Jakoruda and Hadzhidimovo were also awarded city status in the second half of the twentieth century (Penkov and Dojkov 1998). From 1920 to 1975, the population nearly doubled. Noteworthy is Melnik, which has about 200 inhabitants, the smallest city in Bulgaria; 12,000 people lived there in 1912. Causes for this decline are non-sustainable land management, erosion and climate impacts as well as political forces.

The capitalist period was very short in Bulgaria (1912–1944); in many mountain areas it did not arrive. Many of these places reflect original, partly medieval conditions. Socialism was established according to the Soviet model after World War II. Towns such as Blagoevgrad or Razlog were "systematically" developed and selectively industrialized (Fig. 3.7f). Agriculture and forestry were collectivized and mechanized as far as possible in the mountainous regions and among the ethnic groups (Grunewald and Stoilov 1998). In the Struma valley, for example, vegetable growing developed. In the Basin of Razlog and in the Mesta valley the cultivation of tobacco dominated, as did wine near Melnik (Anonymous 1977).

Since 1990, a difficult transition to a market economy has been taking place (Ermann and Ilieva 2006). The economic conditions in industry and agriculture in the mountainous regions of Southeast Europe offer only a few jobs. The connection to Western standards still seems far off although Bulgaria has been a member of the EU since 2007. Borders to neighboring countries have gradually become more porous. Gotse Delchev already benefits from its proximity to Greece. In some places, such as Bansko, winter tourism has recently started booming (see Section 2.5).

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