Summary

Kamniška Bistrica - A Geographic Perspective of a Mountain Valley

The Kamniška Bistrica River and its catchment are located in the northern part of central Slovenia, encompassing the southern part of the Kamnik-Savinja Alps and the north-eastern part of the Ljubljana Basin. The primary area of our study was the northern part of the catchment, upstream of Kamnik, which cuts deep below the highest peaks of the Kamnik-Savinja Alps. Although Kamniška Bistrica is one of the most famous Slovenian mountain valleys, located close to the capital city of Ljubljana, as well as being a popular destination for visitors and hikers, there is not actually much written about it. What is more, most of the available publications are geared towards tourists and hikers, with very few academic texts. The monograph „Kamniška Bistrica - A Geographic Perspective of a Mountain Valley" intends to, at least partially, fill this void. It brings together a collection of contributions from members of the Department of Geography, Faculty of Arts, University of Ljubljana and from a number of guest contributors. The papers are based on research carried out between 2010 and 2012, which students also assisted in through undertaking fieldwork and research tasks.

The Kamniška Bistrica Valley was formed and transformed by different karst, fluviokarst, fluvial and glacial processes, which are largely dependent on the local lithological and structural features. Researchers who have thus far investigated the glaciation of the valley have unanimously suggested that during the last glaciation the glacier filled almost the entire valley. Based on their research, we know that the glacier flowed into the valley from different directions, particularly from the Korošica Plateau below Ojstrica, from Mali and Veliki Podi between Grintovec, Skuta and Turska mountains, and from the direction of Kalce below Kalška Mountain. Massive glacier plateaus fell over the steep slopes down into the Kamniška Bistrica Valley in the form of outlet glaciers or ice avalanches.

Among numerous glacial deposits in the Kamniška Bistrica Valley we identified the outermost moraine ridges that indicate the maximum glacial extent. Several small parallel moraine ridges are located about 600 m south of the confluence of the Korošica and Kamniška Bistrica River. Due to intensive erosion processes in this part of the valley larger traces were not preserved. Whilst it is clear that for a long time the Bistrica Glacier terminus extended to the confluence of Kamniška Bistrica and Korošica, to which point extensive lateral-terminal moraine complexes have been preserved. At their highest positions, moraines reach an altitude of about 680 m, indicating the thickness of the glacier in this part of the valley. Based on altitudes of lateral moraines and alluvial deposits in this section of the valley we can conclude that the thickness of the glacier at this point, 1.5 km from the terminus of the glacier, was at least 150 m.

Higher up the valley a whole series of glacial deposits from retreating stages of the glacier have been preserved. Glacial forms are best preserved above the Kamniška Bistrica Spring, since in that area there are no permanent watercourses which could

transform them through erosion or accumulation. Two well-preserved lateral moraines on Jermanca are very important for interpreting the extent of glaciation, as they indicate the height of glaciers during the Last Glacial Maximum. In the Kamniška Bistrica Valley the glacier was at least 300 m thick, while in the Sedelšček Valley it was 200 m thick. Despite numerous references to the time of glaciation in the literature we do not have any absolute dating which could confirm the claims. It is not known when peak glaciation occurred in the area. We can only infer, based on the agglutination of moraines, that the majority of moraines that are non-agglutinated are most probably from the Würm glaciation.

In reviewing accumulation areas of former glaciers on the tablelands above the Kamniška Bistrica Valley we came across a difficulty when interpreting the glacial plain on the Korošica Plateau. The difficulty arose because the glacier plateau there used to flow in several directions at once. We identified the accumulation areas of this glacier plateau as including both the Kamniška Bistrica and Robanov Kot valleys as well as the slopes above the Lučka Bela Stream and the Savinja River near Luče. This is why it is still not possible to reconstruct the topography of the glacier in the Kamniška Bistrica Valley.

Kamniška Bistrica typically experiences a gradual transition from moderately warm and humid climate to cold and very humid climatic conditions of lower and higher mountain areas. Moderately warm climate patterns of the foothills extend through the valley to Stahovica, whereas moving higher, mountainous climatic conditions begin to take effect. Local climatic characteristics evident in topoclimatic mapping are a result of the modifying effects of relief and land use.

Primary topoclimatic units stem from differences in altitude and the concavity or convexity of the surface. A topoclimate typical of higher mountain areas is present in the Kamnik-Savinja Alps above the upper forest line. It is characterised by lower temperatures (average annual temperature below 2 °C; below 0 °C on the highest ridges), high humidity (average annual precipitation of 2000 to 2600 mm), deep and long-lasting snow cover (average annual snowfall over 4 m; 150 to 200 days with snow cover) and good ventilation (average annual wind speed of 5 to 7 m/s at 10 m above ground level). In terms of insolation, there is a strong duality between exposed sunny slopes (average annual energy of quasi-global radiation 4400 to 4600 MJ/m^2) and shaded slopes (less than 3200 MJ/m^2); there are very few areas with normal insolation. Above sunny slopes, both in the mountains and in lower hilly parts of the studied area, during the day solar radiation leads to a distinct upflow of heated air (anabatic wind). Conversely, during the night cold air flows down from higher elevations into the side and main valleys (katabatic wind). Barren or sparsely vegetated ridges and peaks which are very exposed to strong winds from all directions have their own specific topoclimates. At the micro level, glacial-karst depressions (cirques, big alpine karst depresions - kontas, large and small sinkholes) have a specific climate, experiencing very extreme temperature inversions, especially in winter, when the surface is covered with snow. During the growing season, shrub and grassland landscapes as well as areas with sparse or no vegetation also have specific topoclimates. Due to colour, humidity and porosity of the soil (bedrock), bare or sparsely covered surfaces and the air above such areas become very hot during the day, while cooling significantly at night; meaning that these areas have a large diurnal temperature amplitude.

The remaining sections of the studied area, lying below the upper forest line have a topoclimate of lower mountain areas. Due to their lower altitude, such areas have higher temperatures (average annual temperature of 2 to 10 °C to) and slightly less precipitation (average annual precipitation of 1500 to 2000 mm). They also have less days with snow cover (50 to 150 days), which is also shallower (60 to 200 cm). Due to ridges in the area running predominantly from east to west and the deep cut valleys there is also a very big difference in insolation between southern and northern slopes. On the plains and hills of the southern part of the studied area, in the Kamniška Bistrica Valley and on the Velika Planina Plateau, there is generally normal insolation (average annual energy of quasi-global radiation 3200 to 4400 MJ/m^2). Despite the fact that in the Kamniška Bistrica Valley conditions are not suited to cooling of air by cold air flowing down the valley, temperature inversions nevertheless regularly occur. In lower lying areas more varied land use means there is a more diverse mosaic of topoclimatic units. Noteworthy are the differences between the climate of densely vegetated terrain (forest) and that of more sparsely vegetated areas and farmland, as well as the specific climate present in urbanised areas, especially Kamnik. Three years of measurements taken in May in a beech forest and on a meadow in the upper part of Kamniška Bistrica revealed that maximum daily temperatures in the woods were about 1.5 °C lower than on the meadow, and the daily minimum was more than 3 °C higher. The forest received 20 % less precipitation, while it also had almost 40 % more windless periods. During stable and clear weather Kamnik exhibits a slight urban heat island effect. Based on summer and autumn measurements taken in the first half of the night there is a difference of 1.5 to 3 °C between the warmest and coldest parts of the town, depending on the wind speed. Direct solar radiation is significantly limited at street level in the very densely built up medieval part of Kamnik; around the winter solstice some narrow streets receive no sunshine at all.

According to available resources concerning soils and vegetation, the Kamniška Bistrica Valley is a fairly typical alpine valley. Soil and vegetation maps show largely characteristic distributions of both natural elements, which are primarily conditioned by the hard carbonate bedrock and altitude. However, several years of fieldwork have revealed that there is a much more diverse patchwork of soils and vegetation as evident from the cartographic material or seen at first glance. Vegetation, especially woodland vegetation, exhibits the expected zonality typical of areas with carbonate bedrock and increasing altitude, though it is mediated by local micro-climatic factors, particularly exposition, which can result in much warmer habitats. Steep gradients along with the presence of screes and alluvial fans lower the forest and tree lines as well as break up zonality in many areas. Rapid water flow and limited width of floodplains restrict vegetation growth alongside watercourses to a distinct, but very narrow band.

In the Kamniška Bistrica Valley, the mountain climate together with associated processes and the presence of hard limestone mean that the area is predominantly covered by rendzinas. However, the patchwork of soils has been shown to be much more diverse. The bedrock is still the decisive factor affecting the distribution of soils, though due to the above-mentioned alluvial fans, screes, moraine deposits, as well as non-carbonate rocks, there is much more diversity than is presented on the soil map.

Soils also vary markedly on account of rapid changes in the slope of the terrain, thus in many places rendzinas are replaced by lithosols, the frequency of which increases with altitude. Above the upper forest line, in many places the soil cover enters cracks in the rock, where only chasmophytes can prosper. In spite of the mountain climate, steep slopes and extremely hard bedrock, more developed forms of soils also appear, such as eutric and washed soils. This is evidenced also by the variety in depths/thickness of soils in the valley.

Vegetation belts succeed each other from the southern part of the valley to the north, while simultaneously they are layered in altitudinal zones in the east-west direction. The first, a non-zonal belt, covers a south facing open area of thermophilic beech trees on moderately shallow and skeletal soils, rising to an altitude of approximately 600 m. This is followed by a zonal belt of subalpine beech on typical rendzinas and moderate slopes up to an altitude of about 800 m. To the north, to an altitude of 900 m, the previous zone is encompassed by a higher subalpine area, characterised by beech in shallow rendzinas. The slopes at that point are already steeper, and the climate harsher with a shorter growing cycle. In terms of scale, the altimontane beech trees on shallow rendzinas represent the largest of the zonal areas. The slopes here are even steeper, precipitation exceeds 2500 mm and the zone extends to the upper forest line, which varies between 1600 to 1800 m, depending on the relief and soil conditions. On the eastern slopes, especially below Velika Planina, this zone is succeeded by non-zonal thermophilic altimontane beech and ash trees, where there is high precipitation, extreme gradients and shallow skeletal rendzinas. In the north and the west, there are two more, highest zonal areas above the upper forest line. Extending up to 2000 m is a uniform belt of thermophobic shrubs on lithosols, where there are extreme climate and relief conditions with abundant snow and a very short growing cycle. Above 2000 m, the area is devoid of developed vegetation and soils. The only area that really stands out from the displayed pattern, is an area of silicate rocks in the central to south-western part of the studied area, which contains acidophilic vegetation on acidic soils.

For visitors to the Kamniška Bistrica Valley, one of the main attractions is the river, sharing the same name. The high flow karst spring appears on the surface at an altitude of about 600 m. After travelling more than 30 km it flows into the Sava River at Dol. The catchment area of the Kamniška Bistrica River is significantly branched and covers diverse landscapes, as the river traverses different natural areas (the Kamnik-Savinja Alps, Posavje Hills and the Kamniška Bistrica Plain). The headwaters section, above the confluence with the Nevljica, is mountainous and predominantly karstic and covered in forests. Slopes are steep and precipitation and gradients are high, while evaporation is low. About 70 % of the precipitation drains through watercourses, the specific runoff is approximately 50 L/(s×km^2), with both figures well above the Slovenian average. On average, about 5 m^3/s of water flow along the river bed of the Kamniška Bistrica just above the confluence with the Nevljica. Based on the linear trend, this number is about 20 % lower than it was in the 1960s. The reason for this can be attributed to reduced precipitation and greater evaporation as a result of higher temperatures. As the proportion of snow precipitation in the mountainous part of the basin is relatively large, the Kamniška Bistrica headwaters typically experience a snow-rain flow regime, though on account of proportion of snow

precipitation becoming ever smaller, the snow component is increasingly becoming less pronounced, while the autumnal rain component is increasing due to increasing autumnal precipitation. After heavy and intense precipitation watercourses in the headwaters of the Kamniška Bistrica rise sharply due to their torrential nature, though given the prevalence of narrow and deeply cut valleys, watercourse banks tend to breach only in a narrow band beside river beds, which are mostly uninhabited. Particularly upstream of Stahovica the watercourses are almost completely in a natural state, whilst they also exhibit exceptionally good self-cleaning capacities. The presence of humans and their activities are relatively limited and, with the exception of Velika Planina, confined to the lower, flat terrain. Accordingly, humans there have little impact on water quality. Measurements have shown that the water in the headwaters of the Kamniška Bistrica River is generally unpolluted. There are a couple of good signs for maintaining the quality of water resources in the water and ecologically sensitive karst headwaters, namely that a greater part of the area lies within Natura 2000 areas and that water protection zones have been established above the drainage basin of the Iverja - the main water source of the Kamnik water distribution system.

Further downstream the larger tributaries - Nevljica, Rača and Pšata - flow into the Kamniška Bistrica. This changes the drainage characteristics which in turn transforms the river flow regime in the lower reaches of the Kamniška Bistrica from that of snow-rain into rain-snow. The area frequently experiences floods, which downstream progressively take the form of lowland flooding. The Kamniška Bistrica runs through the towns of Kamnik and Domžale; other sizeable settlements in the basin include Mengeš, Trzin and Vir. Pressures due to wastewater, industry and intensive agricultural activities that, inter alia, contribute to poorer water quality escalate as the river flows on. Self-cleaning capacities have been heavily truncated, particularly because of large-scale construction works in river beds, designed to protect against flooding and erosion. At the beginning of the 21st century, the Kamniška Bistrica in its lower reaches ranked among the most polluted rivers in the country, however through various measures its condition has since significantly improved.

Dynamic and intense natural processes in the mountains often result in a lower carrying capacity of individual environmental components, as is the case with terrain, soil or water, as well as air. At the same time it is this intensity of natural processes that results in the area's increased experiential and utility value from the perspective of tourism and various other industries (energy, mining, forestry, quarries, sand pits...), while also enabling more extensive economic use of space. Though environmental pressures are often low in absolute terms, they may nevertheless exceed carrying capacities and thus lead to an area's ecosystem to be degraded.

A vulnerability study of Kamniška Bistrica has shown that the diversity of the area also presents itself in different degrees of vulnerability. This is especially noticeable when reviewing assessments of vulnerability of individual landscape-forming components. With increasing gradient of slopes the vulnerability of terrain and soils in turn increases, and conversely, by descending in altitude and as terrain becomes more sheltered, self-cleaning capacities of the air reduce and, consequently, vulnerability increases. The plateaus are among the least vulnerable areas, as they are well ventilated, have deeper

soils and more stable terrain, while human and livestock burdens are not excessive. Terrain is the most important cause of increased vulnerability in the area and at the same time represents a major limitation in human activities and nature development. On the whole limited burdens across the entire valley are a positive sign and reveal the generally healthy state of the environment and thus great ecosystem potentials. Yet a relatively low carrying capacity, conditioned by slopes and carbonate rocks, requires extreme caution in planning activities for the area. This aspect justifies the efforts of those who seek to establish a regional park of the Kamnik-Savinja Alps, which would include the Kamniška Bistrica Valley as one of the main valleys.

The area of Kamniška Bistrica has for decades received significant numbers of leisure visits, mostly in the form of day trips. Visitor numbers fluctuate considerably in relation to such factors as weather and season. Most people visit during fine weather weekends during warmer times of the year. From a tourism perspective, factoring in overnight stays at accommodation facilities, Kamniška Bistrica is only moderately important, though there might be more interest for overnight stays by fostering connections with nearby tourist attractions. In this sense, it is worth highlighting the proximity of Velika Planina.

A lot of popular sports and recreational activities that Slovenes engage in are either directly connected with mountainous and hilly areas (alpine skiing, mountaineering/hiking, mountain biking), since appropriate terrain is a prerequisite for engaging in them, or else the picturesque and predominantly natural landscapes serve as desirable venues for partaking in them (jogging in nature, road cycling). In this regard, the Kamniška Bistrica Valley is no exception and it is also on this account that the valley constitutes a leisure area, exceptionally attractive to a wide range of leisure users. Furthermore, Kamniška Bistrica is very important for certain specific groups of leisure users, for example those engaged in mountaineering, ski touring, etc. Though relatively small numbers of individuals engage in these activities, there are relatively few areas in Slovenia whose natural geographical features accommodate them. Therefore, the studied area is especially interesting for such visitors and these activities are highly concentrated here, albeit absolute numbers of visitors are low.

The „typical" visitor to the studied area visits Kamniška Bistrica several times or even regularly, has a particular interest in activities based on walking, and remains in the area for a relatively short time. The main drawcard for visitors is the attractive natural landscape, while a strong factor affecting the decision to visit is also proximity or rather easy accessibility. The latter is significant, making this destination feasible also when available free time is limited. In this way, the area of Kamniška Bistrica fulfills an important function for residents of neighbouring municipalities (Kamnik, Domžale...) as well as the wider Ljubljana urban areas as the easiest and quickest high mountain area to access. Since adequate leisure opportunities are an important factor for quality of life, this function of Kamniška Bistrica deserves a special mention.

Leisure activities are closely associated with transportation which enables people and supplies to reach a particular area. Tourist areas are better served than areas without tourism. Areas attractive to leisure users often experience increased visits which can also have negative consequences, such as congestion, inadequate parking, conflicts between locals and visitors, and generally reduced quality of life; reflected

in environmental as well as economic damage. During the peak tourist season the capacity of transport infrastructure is in many places exceeded and the traffic loads pose a particular problem in this situation.

On fine summer weekends the Kamniška Bistrica Valley experiences heavy traffic burdens. Analysis of the traffic loads in the years 2009 and 2010, along with some earlier data, showed that during the most visited days about 1500 cars entered the valley, while during the week there were only about 300. Moreover, on the most visited days there were between 550 to 700 cars in the valley; a very large number, which calls for reflection on traffic management and calming. Six years after the mentioned traffic study in the Kamniška Bistrica Valley, we find that there has been no progress. Guidelines and measures which were at the time identified and adopted in cooperation with local stakeholders are not being implemented. Traffic arrangements in the valley are still inadequate. Although in 2016 the municipality of Kamnik began preparing an integrated transport strategy, the Kamniška Bistrica Valley is not covered by this document.

It is important to stress that the greatest asset of the Kamniška Bistrica Valley is its pristine nature. The quality of the environment is at the core of its appeal and what attracts so many visitors. Large numbers of visitors, unless managed and supervised, can pose significant burdens on the environment. Visitors to Kamniška Bistrica are still largely left to arrange their visits themselves, which is reflected mainly in the unregulated parking across the valley. Efforts for sustainable mobility in the Kamniška Bistrica Valley have been even further set back since the idea of the Kamnik-Savinja Alps regional park died away. Expanding municipal bus connections between Kamnik and Kamniška Bistrica with the Kamnik Bus was a step in the right direction, but unfortunately it did not last long. Certainly, part of the problem was that this was a standalone measure without adoption of similar measures that would emerge from a clear vision for realisation of sustainable mobility in the Kamniška Bistrica Valley and beyond. Thus, Bohinj remains the only part of the Slovenian Alps that has for many years had in place a clear and systematic transport system plan geared towards sustainable mobility, while all other regions (eg. Logar Valley, Kranjska Gora, Bovec, Bled) only occasionally show any initiative in this sense, however without having a clear vision and with too many ups and downs.