

RELIEF ASPECTS IN SLOVENIA
EKSPOZICIJE POVRŠJA V SLOVENIJI
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Abstract

UDC 911.3:312 (497.12)

Relief aspects in Slovenia

Ridges oriented west-east and northwest-southeast significantly influence the proportion of individual relief aspects in Slovenia. Aspect is an important natural landscape element which has a statistically significant correlation with the proportion of forest, the density of settlements, and the density of population.

Key words: Slovenia, macroregions of Slovenia, geomorphology, demography, relief aspect, forest, settlements, population, digital terrain model, geographical information system.

Izvleček

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Ekspozicije površja v Sloveniji

Deleži površin posameznih ekspozicij so odvisni predvsem od splošne slemenitosti površja v Sloveniji. Med ekspozicijo ter deležem gozda, gostoto naselij in gostoto prebivalstva je statistično pomembna povezanost.

Ključne besede: Slovenija, makroregije Slovenije, geomorfologija, demogeografija, ekspozicije reliefa, gozd, naselja, prebivalstvo, digitalni model reliefa, geografski informacijski sistem.

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1. INTRODUCTION

Relief aspect, which is characteristic of every uneven surface, is the azimuth of direction of the slope in the relief, that is, the angle between due north and the direction of viewing from higher to lower height above sea level. It can also be determined as the direction toward which the relief is turned. Relief aspect therefore indicates which side of the sky the surface is turned to. It is usually expressed by an azimuth sign between 0° and 360° clockwise.

Relief aspect is an important natural landscape element because it influences the amount of solar energy received, an important element in geomorphological, hydrological, pedological, biological, and other natural processes, and at the same time an important factor in settling and diverse other human activities (Gams 1988). Sometimes, it can have decisive importance, for example, in the distribution of vineyards, forests, settlements, ski slopes, and the like.

Incline has an important role in relief aspects. Between relief aspect and incline there is no direct correlation, because the coefficient of their correlation is not statistically significant, although an increase in incline causes an increase in relief aspect and its influence on other landscape elements.

Aspect can be combined in classes named after the sides of the sky. Combining into four 90° wide classes named after four basic sides of the sky is the simplest solution: north aspects have an azimuth between 0° and 45° and 315° and 360° , east aspects between 45° and 135° , south aspects between 135° and 225° , and west aspects between 225° and 315° .

Combining into eight 45° wide classes named after the four basic and four side sides of the sky is more accurate: north aspects have their azimuth between 0.0° and 22.5° and 337.5° and 360.0° , northeast aspects between 22.5° and 67.5° , east aspects between 67.5° and 112.5° , southeast aspects between 112.5° and 157.5° , south aspects between 157.5° and 202.5° , southwest between 202.5° and 247.5° , west aspects between 247.5° and 292.5° and northwest aspects between 292.5° and 337.5° .

In some cases, aspects can only be divided into two 180° wide classes: north aspects (between 0° and 90° and 270° and 360°) and south aspects (between 90° and 270°) or into east aspects (between 0° and 180°) and west aspects (between 180° and 360°).

2. METHODOLOGY

We determined aspects with the help of a digital terrain model and the geographical information system, enabling a relatively simple and quick definition of aspects even for larger areas (Perko 1993).

Aspects in Slovenia were defined with the help of a hundred-meter digital terrain model (Geodesic Office of Slovenia, 1991) containing heights above sea level of the corners of squares in a grid, each square having a base line 100 m long and an area of 10.000 m², i.e. one hectare. On the relief layer we placed centroids of settlement (Geodesic Office, 1992), that is, points representing condensed cores of settlement to which we attached population data. Because of the methodological problems involved in defining centroids of settlement for large areas of settlement such as scattered settlements or settlements consisting of secluded farmsteads (Kokra, Strojna, etc.) and for large settlement areas such as Ljubljana and Maribor, the distribution of settlements and population according to the aspects and the corresponding indexes should be regarded as estimations, which due to the very large amount of data employed are representative enough and reflect a certain legitimacy (Perko 1992 B).

In the framework of the Geographical Information System of Slovenia (Perko 1991) developed at the Anton Melik Geographical Institute primarily for the needs of regional geographical studies and studies of correlations between terrain phenomena (Perko 1992 A), we calculated aspects for 2,025,652 hectare squares with the help of *IDRISI* software (Clark University 1991) which calculated the aspect of each square on the basis of changes in its heights above sea level as well as those of each of eight neighbouring squares. Some 3.4 % of surface in Slovenia has an incline less than 0.5° and for the purposes of this paper such surfaces are treated as level and without aspect. We expected the remaining surface to be equally divided among aspect classes, but in fact, differences are noticeable.

3. FINDINGS

If aspects are divided only into north (azimuth between 0 and 90° and 270 and 360°) and south position (azimuth between 90 and 270°), a good half of Slovenia's surface has a south position, and only a good two fifths has a north position. Or in another words, 18 % more surface area in Slovenia faces south than north. If aspects are divided into east (azimuth between 0 and 180°) and west (azimuth between 180 and 360°) positions, the difference is smaller: 5 % more surface faces east than west.

Differences also exist in average incline. North positions have an average incline of 14.3° and south positions of 13.0°, the difference being 10 %. West positions have average incline of 13.8° and east positions of 13.4 %, the difference being smaller than 3 %. The differences between average height above sea level in north and south positions is nine meters, and between east and west positions five meters.

In Picture 1, south aspects are coloured black, and in Picture 2, east aspects are coloured black. This is actually a very simple example of shading relief with two basic colours

*Figure 1: Aspects with azimuth between 90° and 270° (black).
Slika 1: Ekspozicije z azimutom med 90 in 270° (črno).*

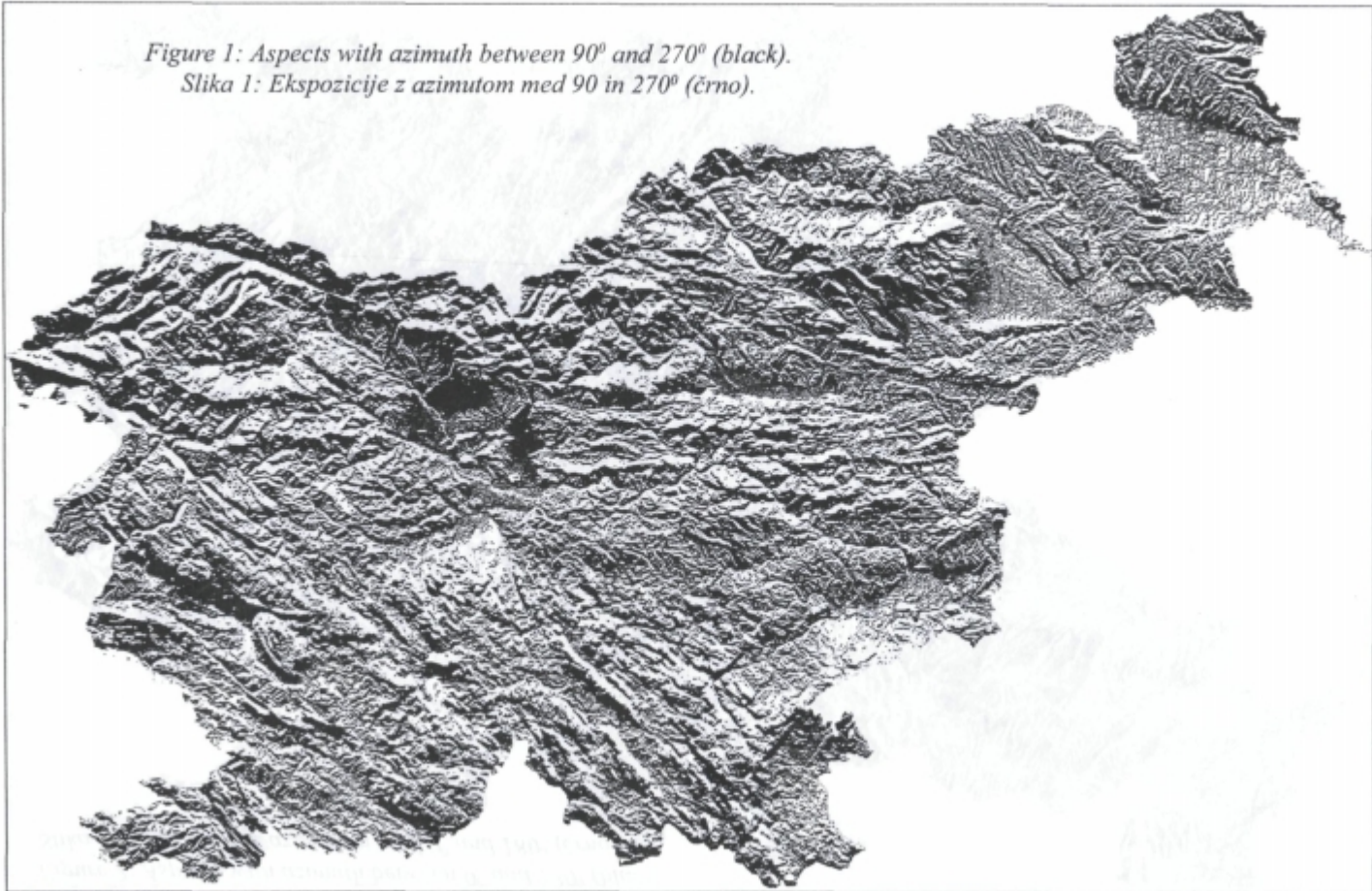


Figure 2: Aspects with azimuth between 0° and 180° (black).
Slika 2: Ekspozicije z azimutom med 0° and 180° (črno).

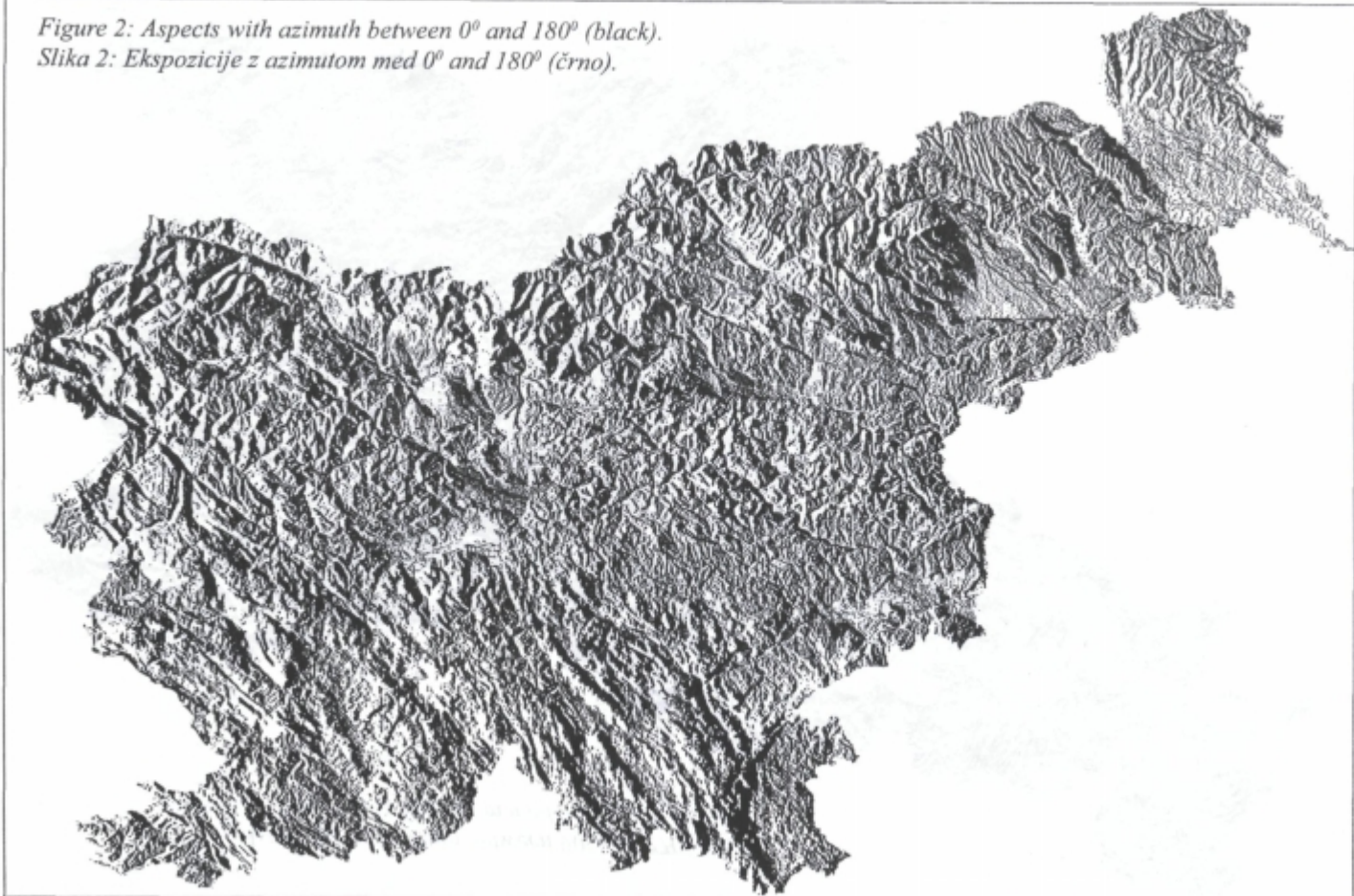


Figure 3: Aspects multiplied by inclines (2 classes, black-white).
Slika 3: Ekspozicije, poudarjene z nakloni (2 razreda, črnobelo).

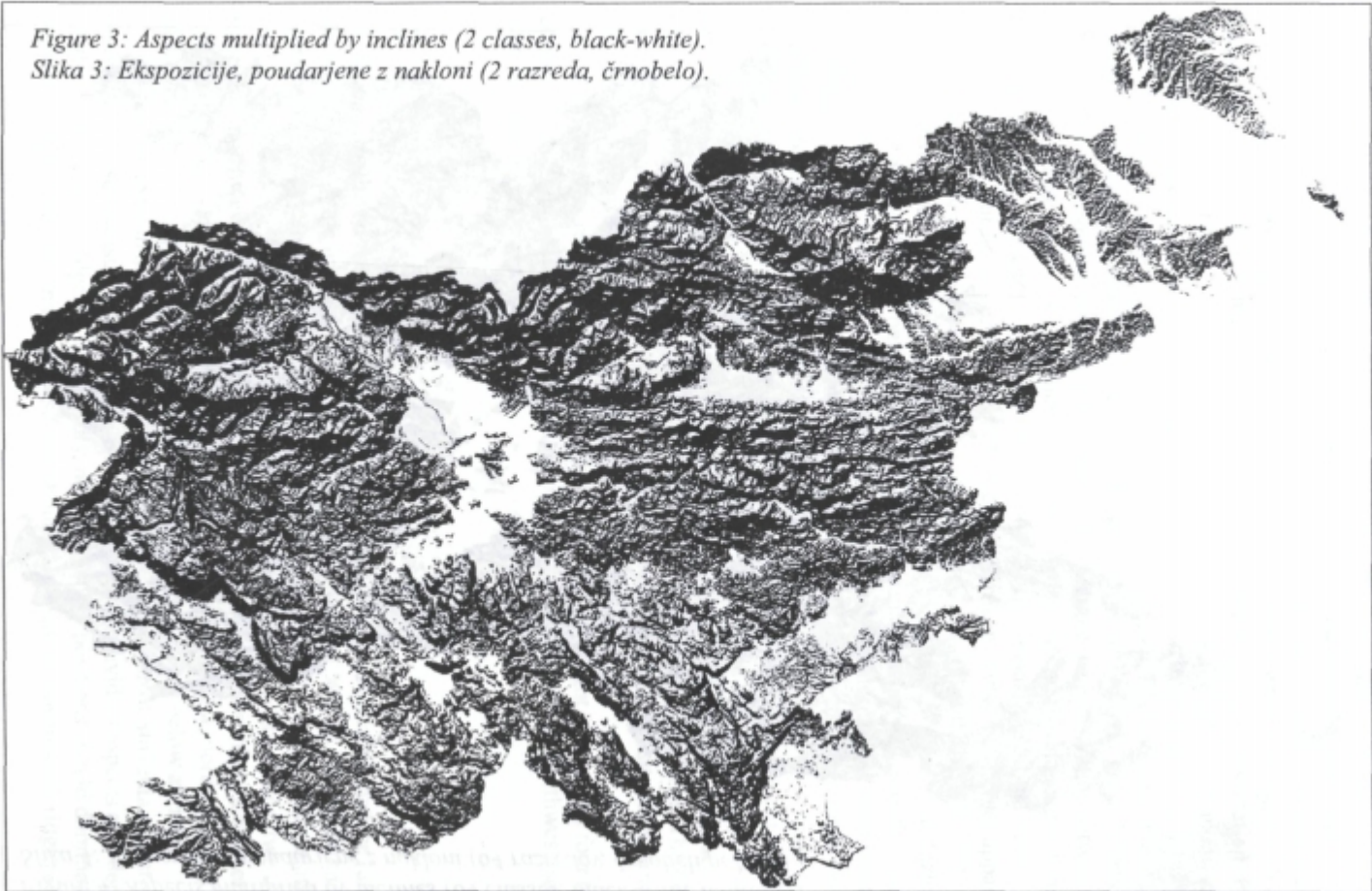
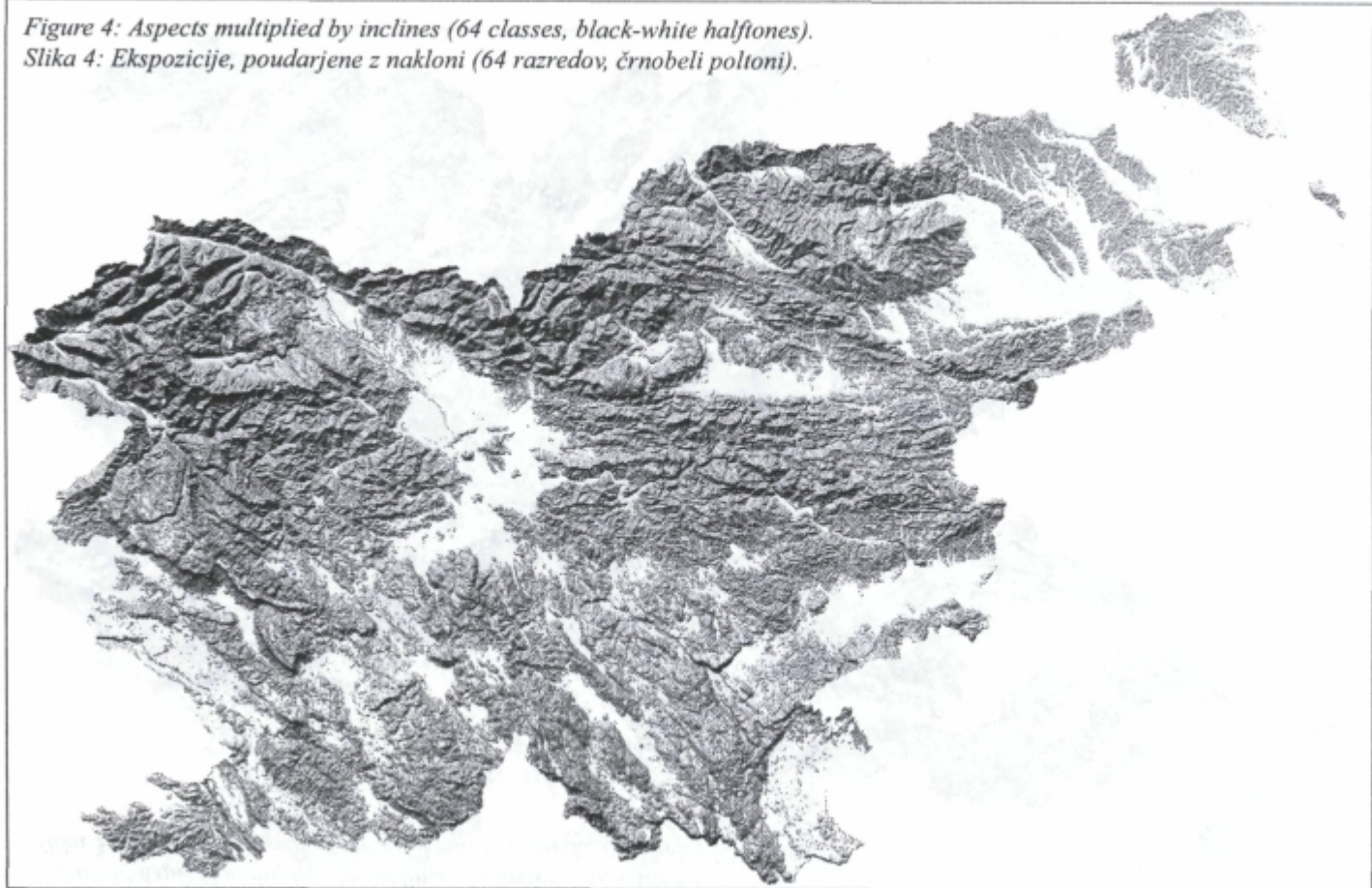


Figure 4: Aspects multiplied by inclines (64 classes, black-white halftones).
Slika 4: Ekspozicije, poudarjene z nakloni (64 razredov, črnobeli poltoni).



without grey halftones: in Picture 1 light comes from the north, and in Picture 2 from the west. Some basic relief characteristics can be seen clearly in the pictures: main faults, ridges, diverse surfaces, etc. If we multiply aspects by inclines, we get Picture 3, in which areas with low values (north aspects and small inclines) are coloured white and areas with high values (south aspects and large inclines) are coloured black. Such a presentation of the relief is even more realistic if white is used to present only the lowest values and black to present the highest values while the values between are presented by grey halftones (Radovan 1992), (Picture 4). Some faults can be clearly seen (for example, the Sava and Idrija fault), as well as individual overlaps (for example the south edge of Trnovski gozd, Nanos and Hrušica) and the larger and more distinct valleys (for example the Sava Valley between the Julian Alps and the Karavanke Mountains, between the Bohinj and Bled lakes and through the Posavsko hills, the Drava Valley between Pohorje and Kozjak, the Kolpa Valley, and Čepovanski dol); furthermore, the ratio of broken to unbroken landscapes is very apparent.

If we divide the aspects into north (azimuth between 0° and 45° and 315° and 360°), east (azimuth between 45° and 135°), west (azimuth between 135° and 225°), and south (azimuth between 225° and 315°) positions, a good quarter of Slovenia's surface has a south position, 23 % each for north and east positions, and one percent less for the smallest, west position. In other words, 21 % more surface in Slovenia faces south than north, 22 % more surface south than east, and 27 % more terrain faces south than west.

North positions have the largest average incline (14.1°), followed by west (13.8°), east (13.5°), and south (13.1°) positions. The difference between the average incline of north and south positions is 8 %. West positions have the highest average height above sea level (571 m), followed by east (569 m), north (566 m), and south (567 m) positions. The difference between average height above sea level between north and south positions is 9 m, and between east and west, 5 m.

Let us have a more exact look at the division of aspects into eight classes: the four basic classes (north, south, east, and west) and the four side classes (northeast, northwest, southwest, and southwest).

3.1. RELIEF

When we subtract completely level surface, that is, 3.4 % of Slovenia's surface (all the flat land with average inclines between 0.0° and 1.9° totals 14.3 %), 12.1 % of the surface remains on average for each of the eight aspects. Actually, there are more south positions, 14.7 %, which is one fifth higher than the average theoretical value, and almost two thirds more than northwest positions which total only 9.2 % of Slovenia's surface, a quarter less than the average value. Above average values are seen in southwest, northeast, and east positions, while figures for west, north, and southeast positions are below average.

This can be explained by the main ridges which divide division of Slovenia in east-west and northwest-southeast directions, because the surfaces of individual aspects also depend on the surfaces of the ridges. Theoretically, north and south positions should dominate on west-east ridges and east and west positions should dominate on north-south ridges. Thus

there are more south and north positions in the alpine world (Table 2) where south and north positions represent almost one third of all areas while east and west positions only represent one fifth of all areas; in Dinaric areas where ridges run northwest-southeast, there are more northeast and southwest positions and northeast and southwest positions represent one third and northwest and southeast positions less than one fifth of all the areas.

That there are a larger number of south aspects than north aspects can be explained by the fact that along Slovenia's northern border, the majority of north slopes are in Austria and of south slopes in Slovenia. The prevalence of east aspects over west aspects can be explained by similar conditions on the border with Italy, where most west slopes belong to Italy and east slopes to Slovenia. On the eastern and southern border towards Croatia, there is more level and hilly relief, so that the slopes are less steep and more extended and therefore cannot replace the missing west slopes in Italy and north slopes in Austria. This can be also attributed to the fact that the borders with Austria and Italy run roughly along crests and ridges while the border with Croatia mostly runs along waterways and thus valleys.

Another possible explanation is that aspects with large areas have smaller inclines and vice versa. Let us pose the basic hypothesis that areas of individual aspects and their average incline are in correlation and the null hypothesis that they are not in correlation or that all the existing differences are accidental. The coefficient of correlation between area and average incline is -0.6632 , which is in the absolute sense a high coefficient, the negative sign indicating that with diminishing inclines, the areas increase. However, the t-test coefficient of correlation indicates that the calculated t, which has a value of 2.1709 , is smaller than the critical value of t, which at 99.9 % validity has a value of 5.959 . Therefore, with 99.9 % probability we can reject the basic hypothesis on correlation and accept the null hypothesis that there is no significant statistically significant correlation between areas of individual aspects and average incline, and thus we cannot say that aspects with smaller average incline have larger areas.

If we compare the distribution of relief aspects according to macroregions in Slovenia (Gams, Kladnik, and Orožen Adamič 1994), the discrepancy is even larger. In the Alpine region, the ratio between the proportion of south positions, which are in majority, and west positions, which are in minority, is almost 2 to 1. On the floor of the Ljubljana Basin, which has the largest number of south positions and the smallest number of northwest positions, the ratio is more than 4 to 1. In the subpannonian area, which has the largest number of south positions and the smallest number of northwest positions, the ratio is 2 to 1. In the Dinaric area, which has the largest number of southwest positions and the smallest number of northwest positions, the ratio is less than 2 to 1. In the submediterranean area, which has the largest number of southwest positions and the smallest number of west positions, the ratio is 2.5 to 1 (Table 2).

The smallest and largest proportions of any aspect are on the floor of the Ljubljana Basin where northwest positions comprise only 5.7 % and south positions as much as 23.7 % (Table 2). In other macroregions the differences are smaller.

Table 1: Areas of individual aspects with average incline and average height above sea level.

Preglednica 1: Površine posameznih ekspozicij s povprečnim naklonom in povprečno nadmorsko višino.

		Surface in hectares	Proportion of surface in %	Average incline in degrees	Average height in metres above sea level
		Površina v ha	Delež površin v %	Povprečni naklon v stop.	Povprečna višina v m
Division into two classes	Delitev na dva razreda				
North	Sever	897490	44,30	14,25	573,49
South	Jug	1059964	52,33	13,04	564,00
Level	Ravno	68198	3,37	0,07	222,80
Total	Skupaj	2025652	100,00	13,13	556,63
East	Vzhod	1000588	49,39	13,44	566,09
West	Zahod	956866	47,24	13,75	570,71
Level	Ravno	68198	3,37	0,07	222,80
Total	Skupaj	2025652	100,00	13,13	556,63
Division into four classes	Delitev na štiri razred				
North	Sever	472494	23,33	14,14	566,43
East	Vzhod	467263	23,07	13,51	568,67
West	Zahod	448175	22,12	13,77	571,49
South	Jug	569522	28,11	13,08	566,91
Level	Ravno	68198	3,37	0,07	222,80
Total	Skupaj	2025652	100,00	13,13	556,63
Division into eight classes	Delitev na osem razredo				
North	Sever	233965	11,55	14,45	571,09
Northeast	Severovzhod	257741	12,72	13,84	560,96

Northwest	Severozahod	185725	9,17	15,06	592,89
East	Vzhod	247720	12,23	12,63	549,32
West	Zahod	217104	10,72	13,79	574,81
Southeast	Jugovzhod	240799	11,89	12,95	570,76
Southwest	Jugozahod	277326	13,69	13,47	566,99
South	Jug	297074	14,67	13,07	567,84
Level	Ravno	68198	3,37	0,07	222,80
Total	Skupaj	2025652	100,00	13,13	556,63

Table 2: Proportion of surfaces of individual aspects by macroregions of Slovenia (omitting level reliefs).

Preglednica 2: Deleži površin posameznih ekspozicij po makroregijah Slovenije (brez ravnega sveta).

Macroregions	Makroregije	N	NE	NW	E	W	SE	SW	S	Total
		S	SV	SZ	V	Z	JV	JZ	J	Skupaj
Alpine	Alpski svet	12,5	10,8	10,3	11,2	9,9	14,2	12,9	18,2	100,0
Western subalpine	Zahodni predalpski svet	13,0	13,8	10,5	12,0	10,6	12,0	13,3	14,8	100,0
Eastern subalpine	Vzhodni predalpski svet	13,8	12,2	10,6	11,7	10,2	12,7	12,8	15,9	100,0
Ljubljana Basin floor	Dno Ljubljanske kotline	7,9	8,9	5,7	11,7	9,2	16,9	16,0	23,7	100,0
Subalpine-subpannonian	Predalpsko-subpanonski svet	10,4	11,5	8,3	13,4	10,6	14,4	14,7	16,7	100,0
Subalpine-Dinaric	Predalpsko-dinarski svet	12,6	16,1	8,2	14,6	8,5	13,2	12,7	14,0	100,0
Subalpine-Littoral	Predalpsko-primorski svet	10,8	11,8	16,4	9,4	18,1	9,7	13,0	10,8	100,0
Subpannonian	Subpanonski svet	10,4	13,0	7,6	16,7	9,9	14,7	11,8	15,9	100,0
Subpannonian-Dinaric	Subpanonsko-dinarski svet	14,2	15,1	13,2	11,7	11,3	11,0	12,3	11,4	100,0
Dinaric	Dinarski svet	11,0	16,3	9,0	13,1	13,1	9,3	16,6	11,7	100,0
Dinaric-Littoral	Dinarsko-primorski svet	12,3	13,5	10,3	11,5	12,3	10,3	16,3	13,5	100,0
Littoral	Primorski svet	14,0	12,3	10,6	7,5	13,4	8,4	19,0	14,7	100,0
Slovenia	Slovenija	12,9	13,2	9,5	12,6	11,1	12,3	14,2	15,2	100,0

3.2. AVERAGE INCLINES

The average incline for Slovenia is 13.1° . Among aspects, northwest positions have the highest average incline at 15.1° , followed by north positions with 14.5° . The lowest average inclines belong to southeast positions with 13.0° and east positions with 12.6° . The difference between highest and lowest average incline is 19° . East, southeast, and south positions have average inclines below the average for Slovenia.

It is interesting how the proportions of individual aspects change according to incline. South or southwest positions dominate for reliefs with inclines between 0° and 6° , southwest positions dominate up to 20° , south positions again dominate up to 50° , northwest positions dominate between 50° and 70° , and north positions dominate above 70° . Slopes of

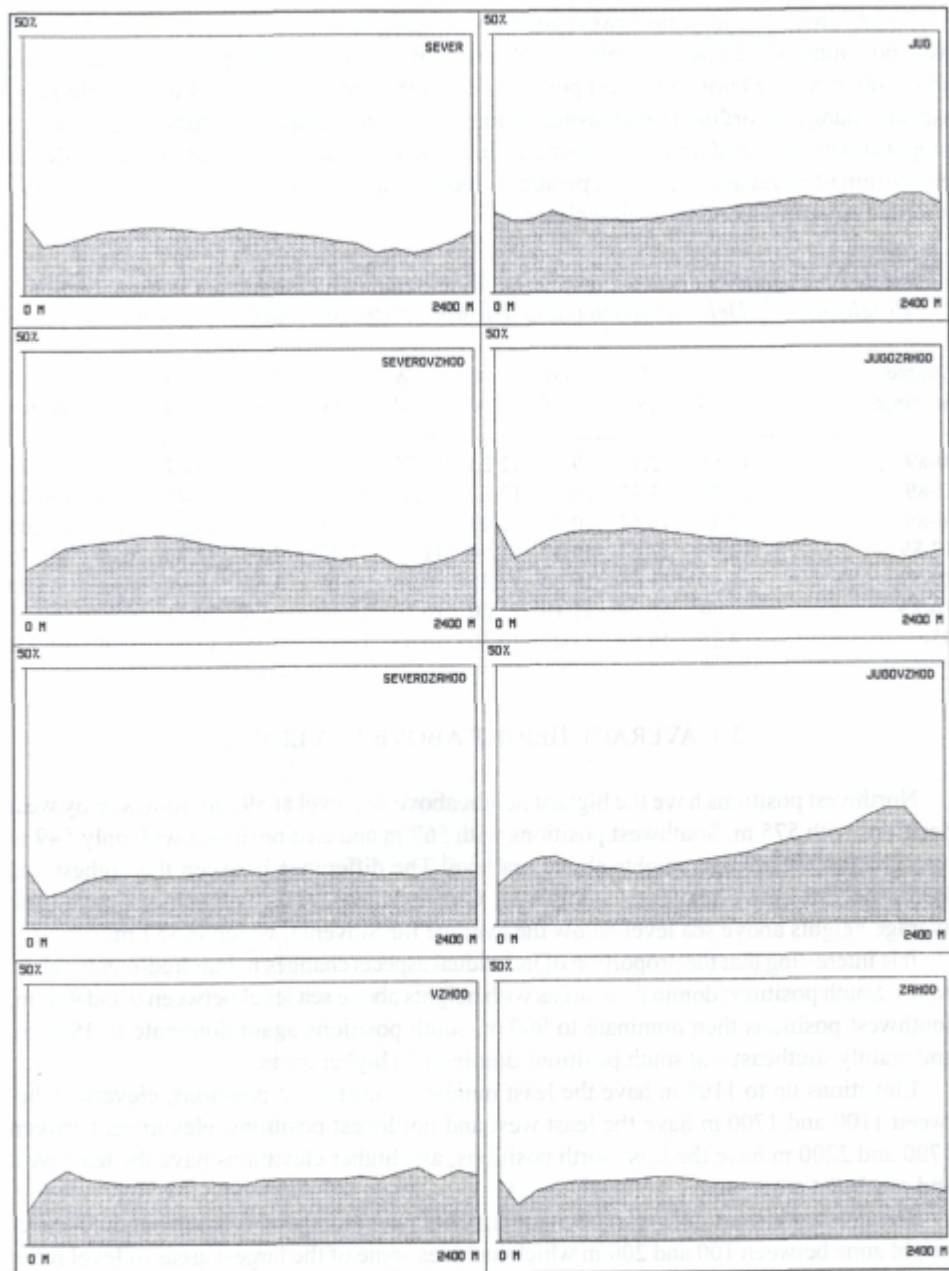


Figure 5: Changing of surface proportions of individual aspects according to increasing incline.

Slika 5: Spreminjanje deleža površin posameznih ekspozicij z rastjo naklona.

30° incline, have the least northwest positions, slopes between 30° and 50° have the least west positions, slopes between 50° and 60° have the least northeast positions, and slopes above 60° have the least southwest positions. How the proportions of reliefs of individual aspects change according to increasing incline is seen in Picture 5. Roughly speaking, the proportion of north and northwest positions increases with the increase of incline while the proportion of south and southwest positions declines, and the remaining positions are represented equally according to all inclines.

Table 3: Proportions of aspects according to incline classes with various lowest limits.
Preglednica 3: Deleži ekspozicij po naklonskih razredih z različno spodnjo mejo.

Degrees Stopinje	N S	NE SV	NW SZ	E V	W Z	SE JV	SW JZ	S J	Level Ravno	Total Skupaj
0-89	11,55	12,72	9,17	12,23	10,72	11,89	13,69	14,67	3,37	100,00
2-89	12,20	13,47	10,03	12,12	11,48	11,75	14,50	14,42	0,03	100,00
6-89	12,45	13,57	10,22	12,03	11,48	11,58	14,39	14,28	0,00	100,00
12-89	12,95	13,64	10,47	11,64	11,37	11,43	14,14	14,36	0,00	100,00
20-89	13,15	13,43	10,80	11,35	10,88	11,80	13,62	14,97	0,00	100,00
30-89	12,74	12,59	11,19	11,00	10,40	12,52	13,45	16,11	0,00	100,00
45-<	14,25	10,54	17,20	10,50	10,93	12,70	10,55	13,33	0,00	100,00

3.3. AVERAGE HEIGHT ABOVE-SEA LEVEL

Northwest positions have the highest height above sea level at 593 m, followed by west positions with 575 m. Southwest positions with 567 m and east positions with only 549 m have the lowest average heights above sea level. The difference between the highest and lowest heights above sea level is only 5 %. Only northeast and east positions have their average heights above sea level below the average for Slovenia, which is 557 m.

It is interesting that the proportion of individual aspects changes in hundred-meter height zones. South positions dominate in areas with heights above sea level between 0 and 400 m, southwest positions then dominate to 900 m, south positions again dominate to 1900 m, and mainly southeast and south positions dominate in higher areas.

Elevations up to 1100 m have the least number of northwest positions, elevations between 1100 and 1700 m have the least west and northwest positions, elevations between 1700 and 2200 m have the least north positions, and higher elevations have the least west and southeast positions.

The primary climax of level relief, that is, relief without aspect, is in the hundred-meter height zone between 100 and 200 m which includes some of the largest areas of level relief in Slovenia, for example, the Pomurska flatlands, the Krško Basin, part of the Vipava Valley, and the northern section of Bela krajina. Secondary climaxes are found between 500 and 600 m, between 700 and 800 m, between 1200 and 1300 m where the largest number of Alpine plateaus lie (for example Jelovica, Pokljuka, and a part of Pohorje), and between

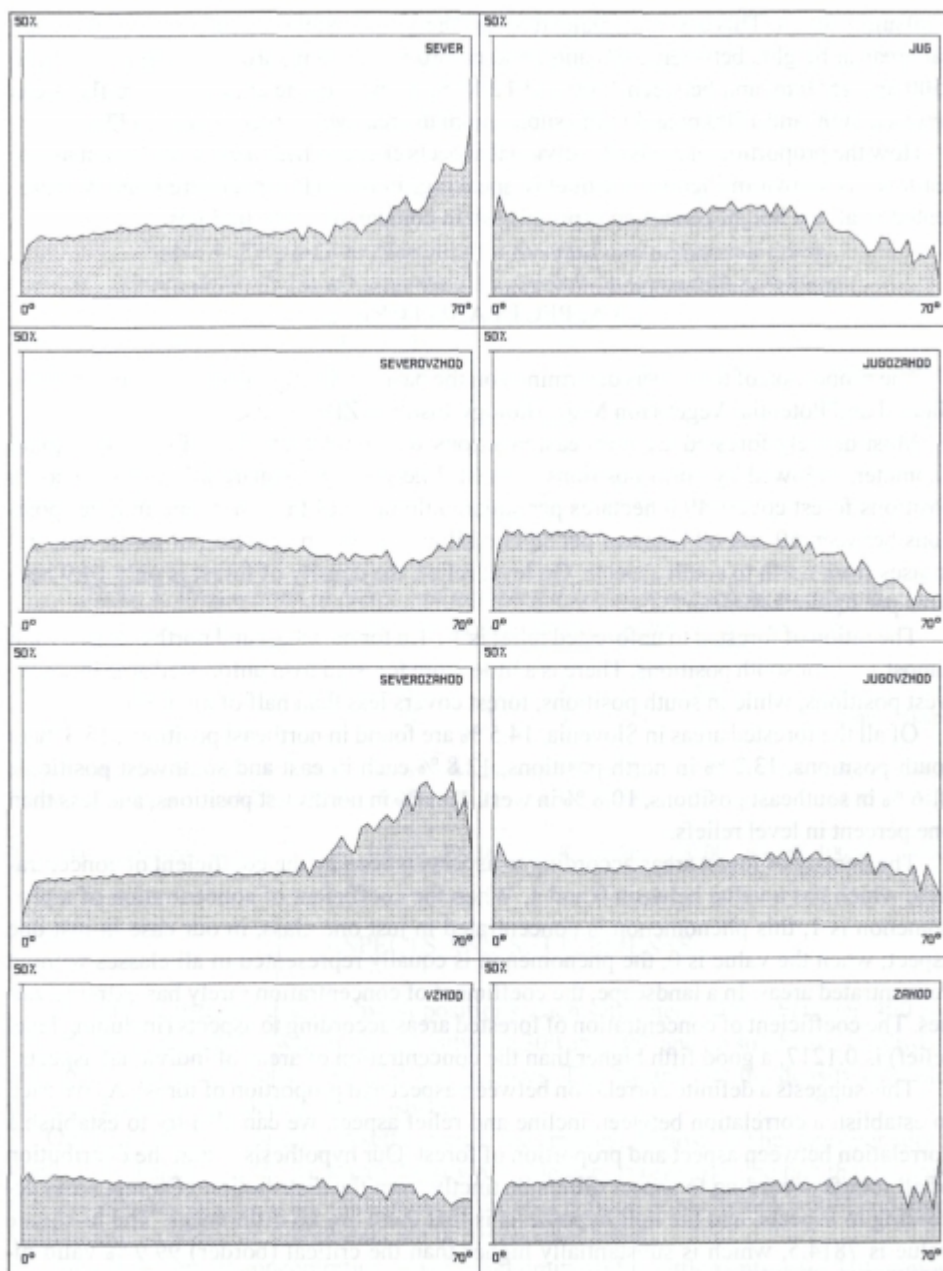


Figure 6: Changing of surface proportions of individual aspects according to increasing height above sea level.

Slika 6: Spreminjanje deleža površin posameznih ekspozicij z rastjo nadmorske višine.

1700 and 1800 m. This can be explained by the fact that in Slovenia's alpine area there are flat areas at heights between 2300 and 2500 m, around 1800 m, around 1600 m, between 1500 and 1550 m, and between 1100 and 1200 m. In the Dinaric area, there are flat areas between 1000 and 1500 m and in the subpannonian area even lower (Šifrer 1972).

How the proportion of areas of individual aspects changes with increasing height above sea level is shown in Picture 6. Roughly speaking, individual aspects are equally represented in all the height zones and especially so in comparison with inclines.

3.4 ASPECTS AND FOREST

The proportion of forest was determined on the basis of the digitalized 1 : 250.000 scale Natural and Potential Vegetation Map (Biology Institute ZRC SAZU).

Most densely forested are northeast positions with 61.9 hectares of forest per square kilometer, followed by north positions with 61.7 hectares per square kilometer. In south positions forest covers 49.0 hectares per square kilometer of the relief, and in other positions between 50 and 60 hectares per square kilometer. The proportion of forest thus decreases from north to south aspects. On level relief, the density of forest is only 14.9 hectares per square kilometer.

The ration of forested to unforested relief is 1 : 1.6 for northeast and north positions and almost 1 : 1 for south positions. There is a little more forested than unforested area in southwest positions, while in south positions, forest covers less than half of all areas.

Of all the forested areas in Slovenia, 14.5 % are found in northeast positions, 13.3 % in south positions, 13.2 % in north positions, 12.8 % each in east and southwest positions, 11.6 % in southeast positions, 10.8 % in west, 10.1 % in northwest positions, and less than one percent in level reliefs.

The density of forest areas according to aspects is seen by the coefficient of concentration, which has a value between 0 and 1. When the coefficient of concentration of a phenomenon is 1, this phenomenon is concentrated in just one class, in our case in just one aspect; when the value is 0, the phenomenon is equally represented in all classes without concentrated areas. In a landscape, the coefficient of concentration rarely has extreme values. The coefficient of concentration of forested areas according to aspects (including level relief) is 0.1217, a good fifth higher than the concentration of areas of individual aspects.

This suggests a definite correlation between aspect and proportion of forest. As we tried to establish a correlation between incline and relief aspect, we can also try to establish a correlation between aspect and proportion of forest. Our hypothesis is that the distribution of all reliefs according to aspect differs distinctly from the distribution of forest areas according to aspects, and the null hypothesis is that there are no differences. The hi-square value is 7814.5, which is substantially higher than the critical (border) 99.9 % valid hi-square value of 24.3 for the eight classes of aspects. Therefore, we may reject the null hypothesis and with 99.9 % probability accept the basic hypothesis that the distribution of reliefs and the distribution of forest differ in a statistically significant way. We can thus conclude that there is a definite correlation between aspect and proportion of forest. The

coefficient of correlation between aspect and the distribution of forested and unforested areas that we calculated on the basis of a contingency table has a value of only 0.0946, which is small in the absolute sense; however, for the more than two million items of data we used in our calculations, the t-test of the coefficient showed that the correlation is statistically significant, because the calculated t with value of 133 is substantially larger than the critical value of t with 99.9 % validity, proving a relatively strong correlation.

Table 4: Proportions of aspects in forested and unforested areas.
Preglednica 4: Deleži ekspozicij po gozdnih in negozdnih površinah.

Surface	Površina	N S	NE SV	NW SZ	E V	W Z	SE JV	SW JZ	S J	Level Ravno	Total Skupaj
Unforested	Negozd	9,64	10,58	8,13	11,54	10,62	12,23	14,71	16,29	6,25	100,00
Forest	Gozd	13,17	14,54	10,05	12,81	10,80	11,59	12,82	13,29	0,92	100,00
Slovenia	Slovenija	11,55	12,72	9,17	12,23	10,72	11,89	13,69	14,67	3,37	100,00

Table 5: Proportions of forest and unforested surfaces according to aspects.
Preglednica 5: Deleži gozdnih in negozdnih površin po ekspozicijah.

Surface	Površina	N S	NE SV	NW SZ	E V	W Z	SE JV	SW JZ	S J	Level Ravno	Total Skupaj
Unforested	Negozd	38,28	38,13	40,65	43,29	45,45	47,20	49,29	50,96	85,15	45,87
Forest	Gozd	61,72	61,87	59,35	56,71	54,55	52,80	50,71	49,04	14,85	54,13
Slovenia	Slovenija	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00	100,00

3.5. ASPECTS AND SETTLEMENTS

On north, northeast, and northwest positions, each settlement covers between 400 and 500 hectares, on east and west positions between 300 and 400, and on southeast, southwest, and south positions between 200 and 300 hectares. This means that the density of settlement increases from north to south aspects.

On level relief, the density of settlement is the smallest, almost 700 hectares per settlement. The explanation for the lower density of settlement is primarily the fact that the land is either devoted largely to agriculture use or the area is flood prone, which would endanger settlements. In addition, settlements are larger on level relief.

The coefficient of concentration (level relief omitted) for settlements is 0.1314, almost three times the coefficient of concentration for areas which have a value 0.0499. This points to the definite importance of aspect in the distribution of settlements; otherwise, both coefficients would be equal.

The basic hypothesis is that the distribution of areas according to aspects is different

from distribution of settlements according to aspects, and the null hypothesis is that it is not. The calculated hi-square has a value of 382.1 and the critical value of the hi-square is 24.3 at 99.9 % validity. So, we can accept basic hypothesis indicating a correlation between aspect and proportion of settlements with 99.9 % probability.

3. 6. ASPECTS AND POPULATION

Population increased in all positions from 1869 to 1991, but in different ways. Between 1869 and 1931, population increased most in southeast positions where it increased almost by half, and least in northeast positions where it increased by only 7 %, meaning that population increased six times as much in southeast positions as in northeast positions. Understandably, population increased most conspicuously in level areas, by almost two thirds.

Between 1931 and 1991, population increased most in east positions, by almost two thirds, and least again in northeast positions, by less than one fifth. In east positions, therefore, population increased almost four times as much as for northeast positions. At the same time, population in level positions increased by 150 %.

Population increased only from 10.4 % to 10.9 % in east positions between 1869 and 1991, in south positions from 20.2 % to 22.8 %, and in level relief more than four times, from 1.7 % to 7.1 %.

In 1991, a good half of the population lived in southeast, southwest, and south positions, and barely one fifth of the population of Slovenia lived in north, northeast, and northwest positions.

In 1869, the most densely populated settlements were southwest positions with 77 people per square kilometer, and the most scarcely populated were northeast positions with 36 people per square kilometer, a 2 : 1 ratio. In 1991, southwest positions were the most densely populated and northeast positions the least, the ratio increasing to more than 3 : 1. On level relief, the density of population was only 51 people per square kilometer in 1869, below the then average for Slovenia, which was 56 people per square kilometer; in 1991, the number was 205 people per square kilometer, four times more than in 1869 and twice more than the average density of population in Slovenia in 1991, 97 people per square kilometer.

The concentration of population according to aspects in 1991 was 0.1714, three and a half times more than the concentration of areas and one third more than the concentration of settlements.

We can establish the significance of aspect by checking the basic hypothesis that the distribution of surfaces of individual aspects typically differs from the distribution of population, and the null hypothesis stating it does not. For 1869, the calculated hi-square value is 75166.9. The critical value of the hi-square at 99.9 % validity is only 24.3. We can therefore accept at 99.9 % probability the basic hypothesis stating that the distribution of surfaces typically differs from the distribution of population. From that year on, the hi-square increased constantly and in 1991 reached the value 223,237, almost ten thousand times more than the critical value. This means that distribution of population is strongly linked to aspect and that it constantly increased between 1869 and 1991.

Table 6: Surfaces, settlements, and population in Slovenia according to aspects.
Preglednica 6: Površine, naselja in število prebivalcev po razredih ekspozicije.

Aspect	Razredi ekspozicije	Area in hectares Površina v ha	Number of settlements Število naselij	Number of population						
				1869	1900	1931	1961	1971	1981	1991
North	Sever	234136	527	102565	114156	122065	137407	149479	163484	179707
Northeast	Severovzhod	257929	551	93455	97709	99606	102664	105596	114383	116740
Northwest	Severozahod	185860	399	79929	91837	100343	111261	120217	129511	134723
East	Vzhod	247900	695	117407	126745	131438	165401	181003	203648	213753
West	Zahod	217262	590	113231	122972	126242	129930	134804	145586	151353
Southeast	Jugovzhod	240974	855	178130	207564	250906	254919	278119	294577	294255
Southwest	Jugozahod	277528	1001	178323	194143	206975	229895	246045	272923	287786
South	Jug	297290	1198	229677	266214	294763	357555	389012	432416	447838
Level	Ravno	68248	102	35025	46548	56434	102491	122862	135336	139831
Total	Skupaj	2027127	5918	1127742	1267888	1388772	1591523	1727137	1891864	1965986

Table 7: Proportions of surfaces, settlements, and population in % in Slovenia according to aspects.

Preglednica 7: Deleži površin, naselij in števila prebivalcev v % po razredih ekspozicije.

Aspect	Razredi ekspozicije	Proportion of surfaces Delež površin	Proportion of settlements Delež naselij	Proportion of population						
				1869	1900	1931	1961	1971	1981	1991
North	Sever	11,5	8,9	9,1	9,0	8,8	8,6	8,7	8,6	9,1
Northeast	Severovzhod	12,7	9,3	8,3	7,7	7,2	6,5	6,1	6,0	5,9
Northwest	Severozahod	9,2	6,7	7,1	7,2	7,2	7,0	7,0	6,8	6,9
East	Vzhod	12,2	11,8	10,4	10,0	9,5	10,4	10,5	10,8	10,9
West	Zahod	10,7	10,0	10,0	9,7	9,1	8,2	7,8	7,7	7,7
Southeast	Jugovzhod	13,7	14,5	15,8	16,4	18,1	16,0	16,1	15,6	15,0
Southwest	Jugozahod	11,9	16,9	15,8	15,3	14,9	14,4	14,2	14,4	14,6
South	Jug	14,7	20,2	20,4	21,0	21,2	22,5	22,5	22,9	22,8
Level	Ravno	3,4	1,7	3,1	3,7	4,0	6,4	7,1	7,2	7,1
Total	Skupaj	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

Table 8: Density of population in numbers of people per square kilometer in Slovenia according to aspects.

Preglednica 8: Gostota prebivalstva v številu ljudi na km² po razredih ekspozicije.

Aspect	Razredi ekspozicije	Density of population Gostota prebivalstva						
		1869	1900	1931	1961	1971	1981	1991
North	Sever	44	49	52	59	64	70	77
Northeast	Severovzhod	36	38	39	40	41	44	45
Northwest	Severozahod	43	49	54	60	65	70	73
East	Vzhod	47	51	53	67	73	82	86
West	Zahod	52	57	58	60	62	67	70
Southeast	Jugovzhod	74	86	104	106	116	122	122
Southwest	Jugozahod	64	70	75	83	89	98	104
South	Jug	77	90	99	120	131	146	151
Level	Ravno	51	68	83	150	180	198	205
Total	Skupaj	56	63	69	79	85	93	97

Table 9: Indexes of population growth in individual periods in Slovenia according to aspects.

Preglednica 9: Indeksi rasti števila prebivalcev v posameznih obdobjih po razredih ekspozicije.

Aspect	Razredi ekspozicije	Indexes of growth of population Indeksi rasti števila prebivalcev								
		1869 1931	1931 1991	1869 1900	1900 1931	1931 1961	1961 1991	1961 1971	1971 1981	1981 1991
North	Sever	119	147	111	107	113	131	109	109	110
Northeast	Severovzhod	107	117	105	102	103	114	103	108	102
Northwest	Severozahod	126	134	115	109	111	121	108	108	104
East	Vzhod	112	163	108	104	126	129	109	113	105
West	Zahod	112	120	109	103	103	117	104	108	104
Southeast	Jugovzhod	141	117	117	121	102	115	109	106	100
Southwest	Jugozahod	116	139	109	107	111	125	107	111	105
South	Jug	128	152	116	111	121	125	109	111	104
Level	Ravno	161	248	133	121	182	136	120	110	103
Total	Skupaj	123	142	112	110	115	124	109	110	104

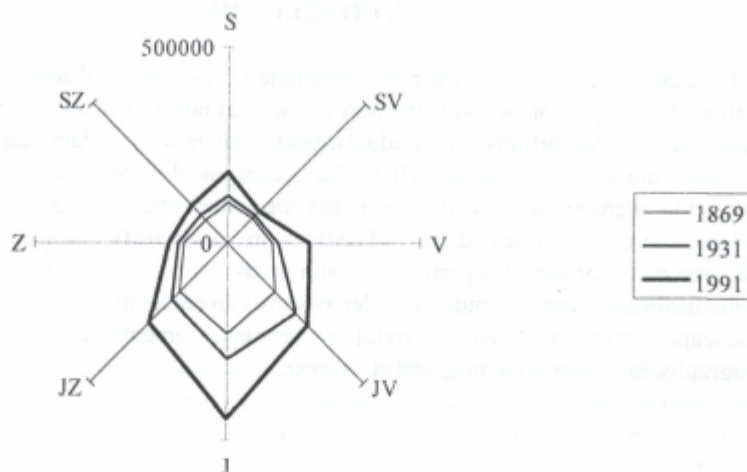


Figure 7: Distribution of population according to aspect and 1869, 1931, and 1991 census figures.

Slika 7: Razporeditev prebivalstva po ekspozicijah ob popisih prebivalstva leta 1869, 1931 in 1991.

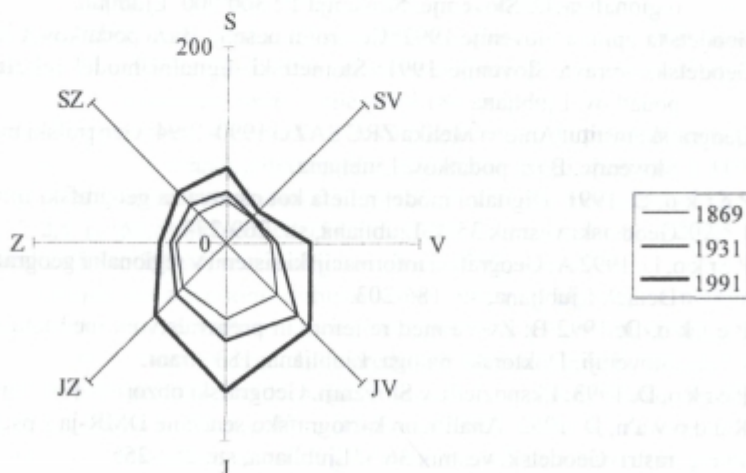


Figure 8: Density of population (number of people per square kilometer) according to 1869, 1931, and 1991 census figures.

Slika 8: Gostota prebivalstva (število ljudi na km²) po ekspozicijah ob popisih prebivalstva leta 1869, 1931 in 1991.

4. CONCLUSION

Because ridge surfaces in the relief dominate in east-west and southeast-northeast directions, the proportion of south and north as well as northeast and southwest positions is above average. Proportions of individual aspects change with the landscape, heights above sea level, and incline. With the help of the geographical information system we demonstrated that there are statistically significant correlations between aspect on the one hand and the proportion of forest, density of settlements, and density of population on the other. The importance of aspect is partly direct and partly indirect, according to other landscape elements; in any event, we must consider aspect as an equal, in some places even decisive, landscape element in studying correlations between elements in the landscape, regional geography, landscape planning, and elsewhere.

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EKSPOZICIJE POVRŠJA V SLOVENIJI

Povzetek

I. UVOD

Ekspozicija reliefa, ki je značilnost vsakega neravnega površja, je azimut smeri zniževanja površja, torej kot med severom in smerjo gledanja od višje proti nižji nadmorski višini. Opredelimo jo lahko tudi kot smer, kamor je obrnjeno površje. Ekspozicija reliefa torej pove, na katero stran neba gleda površje. Običajno jo izražamo z azimutno oznako od 0 do 360° v smeri urinega kazalca.

Ekspozicija reliefa je pomembna naravna pokrajinska prvina (Gams 1988), saj vpliva na količino sprejete sončne energije, ki je pomemben dejavnik pri geomorfoloških, hidroloških, pedoloških, bioloških in drugih naravnih procesih ter hkrati pomemben dejavnik pri poselitvi in različnih dejavnostih človeka. Včasih ima lahko celo odločilen pomen, na primer pri razporeditvi vinogradov, gozda, naselij, smučišč in podobno.

Pomebno vlogo pri ekspozicijah igrajo nakloni. Med ekspozicijo in naklonom sicer ni neposredne povezave, saj koeficient njune povezanosti statistično ni značilen, pač pa z naraščanjem naklona rase izrazitost ekspozicije reliefa in njen vpliv na ostale pokrajinske sestavine.

Ekspozicije lahko združujemo v razrede, ki jih poimenujemo po straneh neba. Najpreprostejše je združevanje v štiri 90° široke razrede, ki jih poimenujemo po štirih osnovnih straneh neba: severne ekspozicije imajo azimut med 0 in 45° in med 315 in 360°, vzhodne med 45 in 135°, južne med 135 in 225°, zahodne pa med 225 in 315°.

V nekaterih primerih (sliki 1 in 2) lahko ekspozicije razdelimo le na dva 180° široka razreda: na severne (med 0 in 90° ter 270 in 360°) in južne ekspozicije (med 90 in 270°) ali na vzhodne (med 0 in 180°) in zahodne ekspozicije (med 180 in 360°).

Bolj natančno pa je združevanje v osem 45° širokih razredov, ki jih poimenujemo po štirih osnovnih in štirih stranskih straneh neba: severne ekspozicije imajo azimut med 0,0 in 22,5° in med 337,5 in 360,0°, severovzhodne med 22,5 in 67,5°, vzhodne med 67,5 in 112,5°, jugovzhodne med 112,5 in 157,5°, južne med 157,5 in 202,5°, jugozahodne med 202,5 in 247,5°, zahodne med 247,5 in 292,5°, severozahodne pa med 292,5 in 337,5°.

Če ekspozicije pomnožimo z nakloni, dobimo sliko 3, kjer so območja z nizkimi vrednostmi (severne ekspozicije in majhni nakloni) bela, območja z visokimi vrednostmi (južne ekspozicije in veliki nakloni) pa črna. Taka predstavitev reliefa je še bolj plastična, še posebej, če z belo barvo predstavimo le najnižje vrednosti in s črno barvo najvišje vrednosti, vmesne vrednosti pa s sivimi poltoni (Radovan 1992), (slika 4). Zelo ostro se vidijo nekateri prelomi (na primer savski in idrijski prelom), nekateri narivi (na primer južni rob Trnovskega gozda, Nanosa in Hrušice), večje in izrazite doline (na primer dolina Save med Julijskimi Alpami in Karavankami, med Bohinjskim in Blejskim jezerom ter skozi Posavsko hribovje, dolina Drave med Pohorjem in Kozjakom, dolina Kolpe in Čepovanska dolina), lepo pa se vidi tudi razmerje med razgibanim in nerazgibanim svetom.

2. NAČIN DELA

Ekspozicije v Sloveniji smo določili s pomočjo geografskega informacijskega sistema, ki omogoča sorazmerno enostavno in hitro določanje ekspozicij tudi za večja območja (Perko 1993), in s pomočjo stometrskega digitalnega modela reliefa Slovenije (Geodetska uprava Slovenije 1991), ki vsebuje nadmorske višine oglišč kvadratne mreže, kjer ima vsak kvadrata osnovnico 100 m, njegova površina pa meri 10 000 m², torej 1 ha. Na reliefni sloj smo položili centroide naselij (Geodetska uprava Slovenije 1992), torej točke, ki predstavljajo zgoštevna jedra naselij, in nanje navezali prebivalstvene podatke. Zaradi metodološke problematičnosti določevanja centroidov naselij za površinsko velika naselja, na primer razložena naselja oziroma naselja iz samotnih kmetij (Kokra, Strojna itd.) ter velika naselja (Ljubljana, Maribor itd.), je treba razporeditev naselij in prebivalstva po ekspozicijah in iz tega izhajajoče kazalce vzeti kot ocene, ki pa so zaradi zelo velikega števila podatkov dovolj reprezentativne in kažejo na nekatere zakonitosti (Perko 1992 B).

V okviru geografskega informacijskega sistema Slovenije (Perko 1991), ki ga predvsem za potrebe regionalnogeografskih preučevanj in preučevanj povezanosti med pojavi v pokrajini (Perko 1992 A), pod naslovom Geografski informacijski sistem Slovenije razvijamo na Geografskem inštitutu Antona Melika Znanstvenoraziskovalnega centra SAZU, smo s pomočjo računalniškega programskega paketa IDRISI (Clark University 1991), ki izračuna ekspozicijo vsakega kvadrata na osnovi spreminjanja nadmorskih višin tega kvadrata in vseh njegovih osmih sosedov, izračunali ekspozicijo za 2 025 652 hektarskih kvadratkov. 3,4 % površja Slovenije ima naklon manjši od 0,5° in tako površje v prispevku obravnavamo kot ravno, torej nima ekspozicije. Pričakovali bi, da je ostalo površje enakomerno porazdeljeno med posamezne razrede ekspozicij, dejansko pa so razlike kar opazne.

3. UGOTOVITVE

3.1. POVRŠINE

Ko odštejemo raven svet, torej 3,4 % površine Slovenije (vsega ravninskega sveta s povprečnim naklonom pod 2° je 14,3 %), ostane v povprečju na vsako od osmih ekspozicij 12,1 % ozemlja. Dejansko pa je največ južnih leg, 14,7 %, kar je za petino več od povprečne, teoretične vrednosti in za skoraj dve tretjini več od severozahodnih leg, ki pomenijo le 9,2 % površine Slovenije, kar je za četrtno manj od povprečne vrednosti. Nadpovprečno se pojavljajo še jugozahodne, severovzhodne in vzhodne lege, podpovprečno pa še zahodne, severne in jugovzhodne lege.

To si lahko razlagamo z glavno slemenitvijo v Sloveniji v smereh zahod - vzhod in severozahod - jugovzhod, saj je površina posameznih ekspozicij odvisna tudi od slemenitve površja. Tako naj bi teoretično pri slemenitvi v smeri zahod - vzhod prevladovale severne in južne lege, pri slemenitvi v smeri sever - jug pa vzhodne in zahodne lege. Zato naj bi bilo v alpskem svetu več južnih in severnih leg, kar drži (preglednica 2), saj južne in severne ekspozicije predstavljajo skoraj tretjino vseh površin, vzhodne in zahodne pa le petino, v

dinarskem svetu s slemenitvijo v smeri severozahod -jugovzhod pa več severovzhodnih in jugozahodnih leg, kar prav tako drži, saj severovzhodne in jugozahodne ekspozicije pomenijo tretjino, severozahodne in jugovzhodne pa niti petino vseh površin.

Večji delež južnih ekspozicij od severnih si razlagamo tudi s tem, da je na severni meji večina severnih pobočij v Avstriji, južnih pa v Sloveniji, prevlado vzhodnih ekspozicij nad zahodnimi pa s podobnimi razmerami na meji z Italijo, kjer v grobem zahodna pobočja pripadajo Italiji in vzhodna Sloveniji. Na vzhodni in južni meji proti Hrvaški pa je več ravninskega in gričevnatega sveta, tako da so pobočja manj strma in bolj podolgovata, zato ne morejo nadomestiti manjka zahodnih pobočij v Italiji in severnih v Avstriji. To lahko opišemo tudi kot dejstvo, da z Avstrijo in Italijo poteka meja večinoma po grebenih in slemenih, s Hrvaško pa predvsem po vodotokih, torej dolinah.

Možna razlaga je tudi, da imajo ekspozicije z večjo površino manjši naklon in obratno. Postavimo osnovno hipotezo, da sta površina posameznih ekspozicij in njihov povprečni naklon povezana, in ničelno hipotezo, ki pravi, da ni povezanosti, oziroma da so vse razlike, ki nastopajo, slučajne. Koefficient povezanosti med površino in povprečnim naklonom je -0,6632, kar je v absolutnem smislu visok koefficient, ki z negativnim predznakom kaže, da se z manjšanjem naklona večja površina. Toda t-test koefficienta povezanosti pokaže, da je izračunani t, ki ima vrednost 2,1709, manjši od kritične vrednosti t, ki ima pri 99,9 % zaupanju vrednost 5,959. Zato lahko z 99,9 % verjetnostjo zavrnemo osnovno hipotezo o povezanosti in sprejmemo ničelno hipotezo, da med površino posameznih ekspozicij in povprečnim naklonom ni statistično pomembne povezanosti. Tako torej ne moremo reči, da imajo tiste ekspozicije, ki imajo manjši povprečni naklon, večjo površino.

Če primerjamo razporeditev površin ekspozicij po makroregijah Slovenije (Gams, Kladnik in Orožen Adamič 1994), lahko ugotovimo še večje neskladje. Tako je v alpskem svetu razmerje med deležem južnih leg, ki jih je največ, in zahodnih leg, ki jih je najmanj, skoraj 2 proti 1. Na dnu Ljubljanske kotline je največ južnih in najmanj severozahodnih leg, razmerje pa je več kot 4 proti 1. V subpanonskem svetu je največ južnih leg in najmanj severozahodnih leg, razmerje pa je 2 proti 1. V dinarskem svetu je največ jugozahodnih leg in najmanj severozahodnih, razmerje pa je manj kot 2 proti 1. V primorskem svetu pa je največ jugozahodnih in najmanj zahodnih, razmerje pa je 2,5 proti 1 (preglednica 2).

Najmanjši in največji delež kakšne ekspozicije je na dnu Ljubljanske kotline, kjer je severozahodnih leg le 5,7 %, južnih pa kar 23,7 % (preglednica 2). Pri drugih makroregijah razlike niso tako velike.

3.2. POVPREČNI NAKLONI

Povprečni naklon Slovenije je 13,1°. Med ekspozicijami imajo največji povprečni naklon severozahodne lege, kar 15,1°, nato pa severne lege s 14,5°. Najmanjši povprečni naklon imajo jugovzhodne lege s 13,0° in vzhodne celo le s 12,6°. Razlika med največjim in najmanjšim povprečnim naklonom je 19 %. Vzhodne, jugovzhodne in južne lege imajo povprečni naklon pod povprečjem Slovenije.

Zanimivo je, da se delež posameznih ekspozicij po naklonih spreminja. Na površju z nakloni med 0 in 6 prevladujejo južne ali jugozahodne lege, nato do 20° predvsem

jugozahodne, nekako do 50° potem spet južne lege, med 50 in 70° severozahodne in nad 70° severne lege.

Na naklonih do 30° je najmanj severozahodnih leg, med 30 in 50° zahodnih, med 50 in 60° severovzhodnih, nad 60° pa jugozahodnih leg.

Kako se spreminja delež površin posameznih ekspozicij z naraščanjem naklona, prikazuje slika 5. V grobem delež severnih in severozahodnih leg z rastjo naklona narašča, južnih in jugozahodnih pada, ostale lege pa so sorazmerno enako zastopane pri vseh naklonih.

3.3. POVPREČNA NADMORSKA VIŠINA

Največjo povprečno nadmorsko višino imajo s 593 m severozahodne lege, nato pa zahodne lege s 575 m. Najmanjšo povprečno nadmorsko višino imajo jugozahodne lege s 567 m in vzhodne z le 549 m. Razlika med največjo in najmanjšo povprečno nadmorsko višino je samo 5 %. Le severovzhodne in vzhodne lege imajo povprečno nadmorsko višino pod povprečjem Slovenije, ki je 557 m.

Zanimivo je, da se delež posameznih ekspozicij po stometrskih višinskih pasovih spreminja. Na površju z nadmorsko višino med 0 in 400 m prevladujejo južne lege, nato do 900 m jugozahodne, nekako do 1900 m potem spet južne lege, višje pa predvsem jugovzhodne in južne lege.

Na nadmorskih višinah do 1100 m je najmanj severozahodnih leg, med 1100 in 1700 m zahodnih in severozahodnih, med 1700 in 2200 m severnih, višje pa zahodnih in jugovzhodnih leg.

Primarni višek ravnega sveta, torej površja brez ekspozicije, je v stometrskem višinskem pasu med 100 in 200 m, kamor spadajo nekatera največja območja ravnega sveta v Sloveniji (na primer Pomurska ravnina, Krška kotlina, del Vipavske doline, pa tudi severni nizki del Bele krajine), sekundarni pa so med 500 in 600 m, 700 in 800 m, 1200 in 1300 m, kjer leži del največjih alpskih planot (na primer Jelovica, Pokljuka), pa tudi del Pohorja, ter med 1700 in 1800 m. To si razlagamo s tem, da imamo v slovenskem alpskem svetu uravnave v višinah med 2300 in 2500 m, okrog 1800 m, okrog 1600 m, med 1500 in 1550 m in med 1100 in 1200 m, v dinarskem svetu med 1000 in 1500 m, v subpanonskem in submediteranskem obrobju pa še nižje (Šifrer 1972).

Kako se spreminja delež površin posameznih ekspozicij z naraščanjem nadmorske višine, prikazuje slika 6. V grobem so posamezne ekspozicije pri vseh višinskih pasovih sorazmerno enako zastopane, sploh pa v primerjavi z nakloni.

3.4. EKSPOZICIJE IN GOZD

Delež gozda smo določali na osnovi digitaliziranega zemljevida Naravne in potencialne vegetacije v merilu 1 : 250 000 (Biološki inštitut Jovana Hadžija ZRC SAZU, 1993).

Najbolj na gosto so z gozdom porasle severovzhodne lege z 61,9 ha gozda na km² površja in severne lege z 61,7 ha na km². Na južnih legah je 49,0 ha gozda na km² površja, na ostalih legah pa med 50 in 60 ha na km². Delež gozda se torej manjša od severnih proti južnim ekspozicijam. Na ravnem svetu je gostota komaj 14,9 ha gozda na km² površja.

Razmerje med gozdnimi in negozdnimi površinami je na severovzhodnih in severnih legah 1 proti 1,6, na južnih pa skoraj 1 proti 1. Na jugozahodnih legah je še za malenkost več gozdnih površin od negozdnih, na južnih legah pa je gozda že manj kot polovico vseh površin.

Od vseh gozdnih površin v Sloveniji jih je 14,5 % na severovzhodnih legah, 13,3 % na južnih legah, 13,2 % na severnih legah, po 12,8 % na vzhodnih in jugozahodnih legah, 11,6 % na jugovzhodnih legah, 10,8 % na zahodnih in 10,1 % na severozahodnih legah, na ravnem pa niti odstotek.

Kakšna je zgostitev gozdnih površin po ekspoziacijah, pokaže koeficient koncentracije, ki ima vrednosti med 0 in 1. Kadar ima koeficient koncentracije nekega pojava vrednost 1, je ta pojav zgoščen v enem samem razredu, v našem primeru na eni sami ekspoziaciji, kadar pa ima vrednost 0, pa je ta pojav enakomerno zastopan v vseh razredih in koncentracije ni. V pokrajini ima koeficient koncentracije le redko skrajne vrednosti.

Koeficient koncentracije gozdnih površin po ekspoziacijah (upoštevaje tudi raven svet) je 0,1217, kar je za dobro petino več, kot koncentracija površin posameznih ekspoziacij. To že kaže na določeno povezanost ekspoziacije z deležem gozda.

Podobno kot smo ugotavljali povezanost naklona in površin ekspoziacije, lahko ugotavljamo tudi povezanost med ekspoziacijo in deležem gozda. Naša hipoteza se glasi, da se razporeditev vseh površin po ekspoziacijah značilno razlikuje od razporeditve gozdnih površin po ekspoziacijah, ničelna hipoteza pa, da razlik ni. Vrednost hi-kvadrata je 7814,5, kar je bistveno več od kritične (mejne) vrednosti hi-kvadrata, ki je pri osmih razredih ekspoziacij in 99,9 % zaupanju 24,3. Zato lahko zavrnamo ničelno hipotezo in z 99,9 % verjetnostjo sprejmemo osnovno hipotezo, da se razporeditev površin in razporeditev gozda statistično pomembno (značilno) razlikujeta. Tako lahko sklepamo, da je med ekspoziacijo in deležem gozda določena povezava. Koeficient povezanosti med ekspoziacijami in razporeditvijo gozdnih in negozdnih površin, ki smo ga izračunali na osnovi kontingenčne tabele, ima vrednost le 0,0946, kar je v absolutnem smislu malo, vendar pa je pri več kot dveh milijonih podatkov, ki smo jih upoštevali pri izračunu, t-test koeficienta pokazal, da je povezanost statistično značilna, saj je izračunani t z vrednostjo 133 bistveno večji od kritične vrednosti t pri 99,9 % zaupanju, kar dokazuje sorazmerno močno povezanost.

3.5. EKSPOZICIJE IN NASELJA

Na severnih, severovzhodnih in severozahodnih legah pride na vsako naselje med 400 in 500 ha površine, na vzhodnih in zahodnih legah med 300 in 400 ha, na jugovzhodnih, jugozahodnih in južnih legah pa med 200 in 300 ha. To pomeni, da se gostota naselij veča od severnih proti južnim ekspoziacijam.

Na ravnem svetu pa je gostota naselij najmanjša, skoraj 700 ha na naselje. Razlog za manjšo gostoto naselij je predvsem v tem, da je raven svet prepuščen v večji meri kmetijski izrabi, ali pa so to poplavna območja, kjer bi bila naselja ogrožena. Razen tega, da je naselje na ravnem svetu res manj, pa drži tudi dejstvo, da so le-ta tam večja.

Koeficient koncentracije za naselja je 0,1314 (raven svet je izločen), kar je skoraj trikrat

več od koeficienta koncentracije za površine, ki ima vrednost 0,0499. To kaže na določen pomen ekspanzije za razporeditev naselij, saj bi si bila sicer oba koeficienta enaka.

Osnovna hipoteza se glasi, da je razporeditev površin po ekspanzijah različna od razporeditve naselij po ekspanzijah, ničelna hipoteza pa, da ni. Izračunani hi-kvadrat ima vrednost 382,1, kritična vrednost hi-kvadrata pri 99,9 % zaupanju pa 24,3. Zato lahko z 99,9 % verjetnostjo sprejmemo osnovno hipotezo, ki kaže na povezavo med ekspanzijo in deležem naselij.

3.6. EKSPANZIJE IN PREBIVALSTVO

Število prebivalcev je od leta 1869 do leta 1991 raslo prav na vseh legah, vendar različno. Med letoma 1869 in 1931 je najbolj naraščalo na jugovzhodnih legah, kjer se je število prebivalcev povečalo skoraj za polovico, najmanj pa na severovzhodnih legah, kjer se je povečalo le za 7 %. Na jugovzhodnih legah se je torej število prebivalcev povečalo šestkrat bolj kot na severovzhodnih legah. Najbolj izrazito pa se je število prebivalcev, razumljivo, povečalo na ravnem svetu, skoraj za dve tretjini.

Med letoma 1931 in 1991 se je število prebivalcev najbolj povečalo na vzhodnih legah, skoraj za dve tretjini, najmanj pa spet na severovzhodnih legah, za manj kot petino. Na vzhodnih legah se je tako število prebivalcev povečalo za skoraj štirikrat bolj kot na severovzhodnih legah. Na ravnem svetu se je v istem obdobju število prebivalcev povečalo za 150 %.

Delež prebivalstva se je med letoma 1869 in 1991 povečal le na vzhodnih legah z 10,4 % na 10,9 % in južnih legah z 20,2 % na 22,8 %, ter seveda na ravnem svetu, kjer se je delež povečal kar za več kot štirikrat, z 1,7 % na 7,1 %.

Leta 1991 je na jugovzhodnih, jugozahodnih in južnih legah živela dobra polovica, na severnih, severovzhodnih in severozahodnih legah pa komaj petina vsega prebivalstva Slovenije.

Leta 1869 so bile najbolj goste naseljene jugozahodne lege s 77 ljudmi na km², najbolj redko pa severovzhodne lege s 36 ljudmi na km². Razmerje je bilo približno 2 proti 1. Leta 1991 so bile spet najbolj goste naseljene jugozahodne in najmanj severovzhodne lege, razmerje pa je naraslo na več kot 3 proti 1. Na ravnem svetu je bila gostota prebivalstva leta 1869 komaj 51 ljudi na km², kar je pod takratnim povprečjem Slovenije, ki je bilo 56 ljudi na km², leta 1991 pa že 205 ljudi na km², kar štirikrat več kot leta 1869 in več kot dvakrat več od povprečne gostote prebivalstva Slovenije leta 1991, ki je bila 97 ljudi na km².

Koncentracija prebivalstva po ekspanzijah je bila leta 1991 0,1714, kar je triinpolkrat več od koncentracije površin in za tretjino več od koncentracije naselij.

Tudi za razmestitev prebivalstva lahko ugotavljamo pomen ekspanzije s preizkusom osnovne hipoteze, ki se glasi, da se razporeditev površin posameznih ekspanzij značilno razlikuje od razmestitve prebivalstva, in ničelne hipoteze, da se ne. Za leto 1869 ima izračunani hi-kvadrat vrednost 75166,9. Ker je kritična vrednost hi-kvadrata pri 99,9 % zaupanju samo 24,3, lahko z 99,9 % verjetnostjo sprejmemo osnovno hipotezo, da se razporeditev površin značilno razlikuje od razporeditve prebivalstva. Od tega leta naprej je hi-kvadrat stalno naraščal in leta 1991 dosegel vrednost 223 237, kar je skoraj desetisočkrat

več od kritične vrednosti. To pomeni, da je razporeditev prebivalstva močno navezana na ekspozičijo in da je med letoma 1869 in 1991 stalno naraščala.

4. SKLEP

V Sloveniji imajo zaradi slemenitve reliefa v prevladujočih smereh vzhod - zahod in jugovzhod - severozahod nadpovprečno visok delež površin južne in severne ter severovzhodne in jugozahodne lege. Deleži posameznih ekspozičij se spreminjajo s pokrajinami, z nadmorsko višino in naklonom. S pomočjo geografskega informacijskega sistema smo dokazali, da je med ekspozičijo na eni strani ter deležem gozda, gostoto naselij in gostoto prebivalstva na drugi strani statistično pomembna povezanost. Pomen ekspozičije je deloma neposreden in deloma posreden, prek drugih pokrajinskih prvin, vsekakor pa moramo ekspozičijo pri preučevanju povezav med pojavi v pokrajini, regionalni geografiji, pokrajinskem načrtovanju in drugod upoštevati kot enakovredno, ponekod celo odločujočo pokrajinsko prvino.