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CORRELATION ANALYSIS DEMOGRAPHIC-ECONOMIC VARIABLES AND LAND USE/LAND COVER VARIABLES OF CENTRAL LIKA

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Land use/land cover characteristics are the result of demographic-economic processes. The aim of this research was to define and explain the direction and degree of correlation chosen demographic-economic variables and land use/land cover variables of Central Lika. The correlations were determined by using the Spearman's rank correlation coefficient, with the computer program IBM SPSS Statistics 20. For that purpose the demographic and economic data of the year 2011 and the land use/land cover data of the year 2013 were used. Research results have shown existence of a correlation of all observed pairs of variables. The complete and strong correlations that were found between many of the variables correspond to the geographical reality in the study area.

Key words: *Correlation Analysis, Spearman's rank correlation coefficient, IBM SPSS Statistics 20, Central Lika*

INTRODUCTION

Land use/land cover characteristics are the result of demographic-economic processes. The aim of this research is to define and explain the direction and degree of correlation chosen demographic-economic variables and variables pertaining to land use and land cover in Central Lika. The direction and degree of correlation are established by calculating the value of Spearman's rank correlation coefficient, comprised in the computer program *IBM SPSS Statistics*, version 20.

The study area, Central Lika**,** is situated in the central part of the Lika region, one of the mountain regions in the Republic of Croatia. Previous research on the area has mostly focused on topics of social geography and demogeography, and to a lesser degree, on topics of physical geography. The interdependence between the characteristics of geographical basis and historical geographic population cycles of Central Lika, namely the basis for understanding its socio-geographic processes, has been the topic of research by D. Pejnović (1985). In his work from 2004, the same author claims that the peripheral nature of Lika, which resulted from cumulative influence of multiple factors, leads to intense emigration and leaves deep unfavourable consequences on age structure and natural population change. In addition, the same author claims that Central Lika was already in the stage of population extinction in the 1970s. Furthermore, development of Central Lika's landscape caused by the influence of socioeconomic processes is the topic of research by M. Jovanić (2014). Through the application of GIS, M. Pahernik and M. Jovanić (2014) proposed in their work the established geomorphologic database for Central Lika, which, due to clearly defined objects within it, can be related to other geoscientific databases which will comprise other geographical components for the area of Centra Lika.

The work by I. Šošić and V. Serdar (2002) proposes a broader review of relevant statistical methods, as well as an explanation for the measurement of the correlation degree obtained by calculation Spearman's rank correlation coefficient.

METHODOLOGY

Study area

The basis for Central Lika's regional isolation is provided by the geographical setting of Mt. Velebit, on its west and south-west sides, Lika highlands on the east side, and mountain range Resnik on its south-east side.

The majority of surface area of the Central Lika basin is occupied by fluvial-karst plateau Lika, broken up by karst mounts and karst fields. Between them, Lika polje covers the most surface area, being the greatest karst field in the Republic of Croatia. However, Lika polje is not a continuous plateau – it consists of several smaller karst fields (Pejnović 1985). The west and south-west rim of the study area consist of steep slopes of northern, middle and southern Mt. Velebit, whose highest peak (Vagan Peak 1757 m) is located in the study area. The east and south-east rims of the study area, placed on a lower height above sea level, are comprised of Lika highlands and mountain range Resnik. The scope of height above sea level in the study area is between 461 and 1757 m, and the average height above sea level is 740 m (Pahernik and Jovanić 2014).
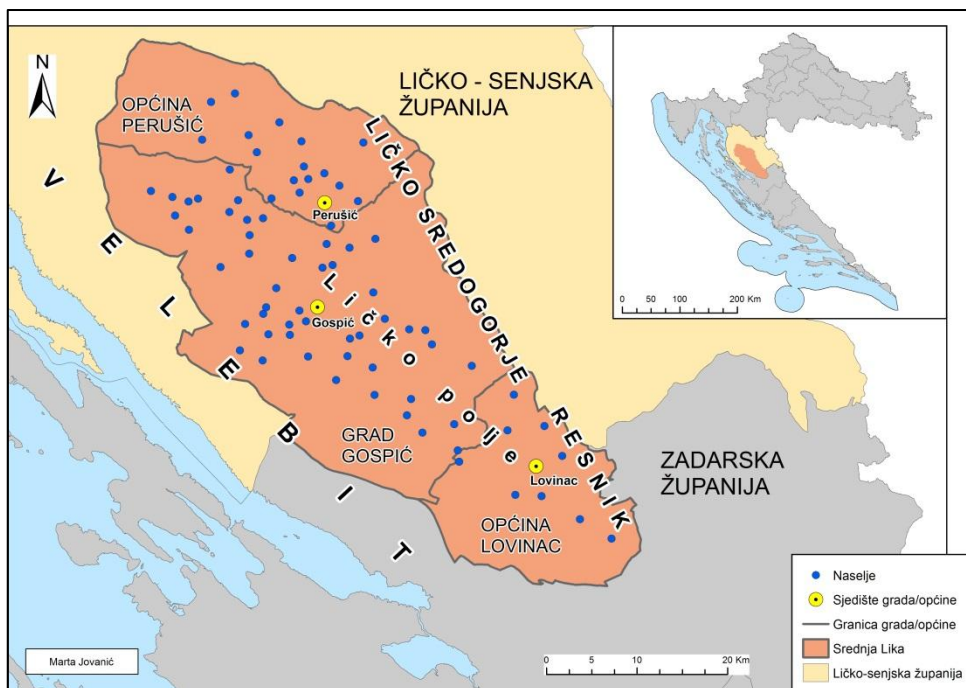

Fig. 1 Central Lika – study area

Central Lika encompasses the area of three units of local government: Gospić Town, Lovinac Municipality and Perušić Municipality, the integral part of Lika-Senj County (Fig. 1). Their centres are located in the settlements of the same name (Gospić, Lovinac and Perušić). The total surface area of Central Lika is 1690 km^2. Gospić Town occupies the surface of approximately 967 km^2, while smaller surface area is occupied by Perušić Municipality (approx. 381 km^2) and Lovinac Municipality (approx. 342 km^2).

In accordance with the trends that has been taking place since the end of Second World War, the majority of the Central Lika area has been affected by the demographic-economic processes of population decline, deruralization, population ageing and deagrarization. The negative intensity of those processes particularly affected the marginal areas, further away from the settlements of Gospić and Lički Osik (Jovanić 2014). In the landscape, the mentioned demographic-economic processes have been manifested in abandonment of land properties previously used for agriculture and its natural reforestation. The process of natural reforestation has been taking place gradually: first a cover of low vegetation has been appearing, then it gradually has been growing into more and more dense vegetation, and the final stage is the formation of forest cover.

Metoda istraživanja i korišteni podaci
Research method and data sources

Since land use/land cover characteristics are the result of demographic-economic processes, the aim of this research is to define and explain the direction and degree of correlation of the chosen demographic-economic variables and variables pertaining to land use and land cover in Central Lika. That was done by calculating the value of Spearman's rank correlation coefficient comprised in the computer program *IBM SPSS Statistics*, version 20. That coefficient was used because it matches the aim of this research, which is to analyze the statistical correlation (the direction and degree of correlation) of the observed pairs of variables.
Spearman's rank correlation coefficient is given by the expression (Šošić and Serdar 2002):

$$r_s = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n^3 - n} \ , \quad -1 \leq r_s \leq 1$$

r_s ⋯ Spearman's rank correlation coefficient
d_i ⋯ difference between rank-variables r (x_i) and r (y_i)
n ⋯ sample size

It is evident that the value of Spearman's rank correlation coefficient lies in the closed interval from − 1 to + 1. The value −/+ 1 for r_s indicates the complete correlation in the negative/positive direction, whereas the value 0 indicates the non-existence of correlation. Other values, those between − 1 and +1, indicate the degree of correlation. The values closer to −/+1 indicate a stronger rank correlation, while the values closer to 0 indicate a weaker rank correlation (Šošić and Serdar 2002).

The correlation analysis was undertaken with demographic-economic variables and land use/land cover variables pertaining to all three units of local government of Central Lika, and to Central Lika as a whole. The reason for using the units of local government as

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unit values lies in the fact that the majority of their administrative borders correspond to the borders of marginal cadastre municipalities[1]. In other words, the pairs of variables (demographic-economic variables and land use/land cover variables) put into correlation can be compared because they pertain to the same area.

The used demographic-economic variables were obtained from the Croatian Bureau of Statistics' official data for the last population census in the Republic of Croatia, taken in 2011. The data on land use/land cover were obtained from the State Geodetic Directorate, branch-office Gospić, and pertain to the date of 27th August, 2013 (Tab. 1).

Tab. 1 Demographic-economic variables and Land Use/Land Cover variables used in the correlation analysis

VARIABLES	AREA			
	GOSPIĆ TOWN	LOVINAC MUNICIP.	PERUŠIĆ MUNICIP.	CENTRAL LIKA
Demographic-economic variables				
Population density (inh./km^2)	13,1799	2,9444	6,9239	9,6982
Proportion of young population (0-19)	21,5536	15,7895	15,2767	20,1891
Proportion of mature population (20-59)	52,0910	40,6157	44,0106	50,0854
Proportion of older population (≥ 60)	26,3554	43,5948	40,7127	29,7255
Proportion of the population without education or with incomplete elementary education in the total educated population	16,3806	29,6928	34,0580	20,1936
Proportion of population with elementary and secondary education in the total educated population	69,1045	64,1638	59,4203	67,1639
Proportion of population with college, university, MA and PhD degree in the total educated population	14,5149	6,1434	6,5217	12,6425
Proportion of economically active (employed and unemployed) population in the total population	43,6900	28,3276	29,8934	40,4016
Proportion of economically inactive population in the total population	56,3100	71,6724	70,1066	59,5984
Proportion of the population with income from agriculture in the total population	1,3025	3,3764	8,8704	2,6480
Proportion of population which lives from independent work in the total population	31,4712	18,3714	20,8870	28,9628
Proportion of population with income from old-age pension in the total population	15,2923	21,7478	19,5982	16,3819
Proportion of population without income in the total population	30,8356	23,0387	25,4359	29,4875

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[1]In the study area the marginal borders of the Štikada cadastral municipality do not correspond to the administrative borders of the Štikada settlement (Štikada settlement occupies a larger surface). In this research we didn't consider the values for the cadastral municipality Štikada, but we did consider the vaules for the whole area of Lovinac Municipality, including Štikada settlement.

Proportion of occupied dwellings in the total dwellings for permanent residence	63,1543	45,4361	73,4496	62,9993
Proportion of temporarily unoccupied dwellings in the total dwellings for permanent residence	34,5615	52,8398	9,8191	32,5109
Proportion of abandoned dwellings in the total dwellings for permanent residence	2,2842	1,7241	16,7313	4,4898
Land use/land cover variables				
Proportion of agricultural land*	95,0580	96,6411	88,8521	93,9243
Proportion of forest land	0,2437	0,6740	8,1868	2,1539
Proportion of natural infertile land	0,0003	0,0090	0,0000	0,0019
Proportion of built land	3,6087	1,7133	1,8589	2,8513
Proportion of water surface	1,0893	0,9626	1,1022	1,0686
**Average size of cadastral lot (in ha)	0,6167	0,6309	0,5909	0,6131

Source: Census of Population, Households and Dwellings 2011 (www.dzs.hr); Land Use/Land Cover data, State Goedetic Directorate, branch-office Gospić, 2013.

*Agricultural land encompasses not only the used land, but also the total available agricultural land.

**The average size of a cadastral lot was obtained by calculating the data obtained from the State Geodetic Directorate, branch-office Gospić.

NOTE: The values of all variables are viewed with the precision of four decimal digits. The reason is the small difference between the values of some of the variables in question, whose accuracy in the calculation of the Spearman's rank correlation coefficient is crucial.

RESULTS AND DISCUSSION

Based on the result of the correlation analysis of the demographic-economic variables and land use/land cover variables (Tab. 2), the mutual relationships in the area of Central Lika can be explained into greater detail.

Tab. 2 Results of the correlation analysis demographic-economical variables and Land Use/Land Cover variables

	Land Use/Land Cover variables					
Complete correlation Strong correlation Weak correlation	Proportion of agricultural land	Proportion of forest land	Proportion of natural infertile land	Proportion of built land	Proportion of water surface	Average size of cadastral lot (in ha)
Demographic-economic variables						
Population density (inh./km^2)	-0,2	-0,4	-0,4	1,0	0,4	-0,2
Propotion of young population (0-19)	0,4	-0,8	0,2	0,8	-0,2	0,4
Proportion of mature population (20-59)	-0,2	-0,4	-0,4	1,0	0,4	-0,2
Proportion of older population ($\geq$ 60)	0,2	0,4	0,4	-1,0	-0,4	0,2

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Proportion of the population without education or with incomplete elementary education in the total educated population	-0,4	0,8	-0,2	-0,8	0,2	-0,4
Proportion of population with elementary and secondary education in the total educated population	0,4	-0,8	0,2	0,8	-0,2	0,4
Proportion of population with college, university, MA and PhD degree in the total educated population	-0,2	-0,4	-0,4	1,0	0,4	-0,2
Proportion of economically active (employed and unemployed) population in the total population	-0,2	-0,4	-0,4	1,0	0,4	-0,2
Proportion of economically inactive population in the total population	0,2	0,4	0,4	-1,0	-0,4	0,2
Proportion of the population with income from agriculture in the total population	-0,4	0,8	-0,2	-0,8	0,2	-0,4
Proportion of population which lives from independent work in the total population	-0,2	-0,4	-0,4	1,0	0,4	-0,2
Proportion of population with income from old-age pension in the total population	0,2	0,4	0,4	-1,0	-0,4	0,2
Proportion of population without income in the total population	-0,2	-0,4	-0,4	1,0	0,4	-0,2
Proportion of occupied dwellings in the total dwellings for permanent residence	-0,8	0,4	-1,0	0,4	1,0	-0,8
Proportion of temporarily unoccupied dwellings in the total dwellings for permanent residence	1,0	-0,8	0,8	-0,2	-0,8	1,0
Proportion of abandoned dwellings in the total dwellings for permanent residence	-1,0	0,8	-0,8	0,2	0,8	-1,0

The research results established the existence of correlation of all considered pairs of variables, demographic-economic variables and land use/land cover variables.

Built land

The correlations of the proportion of built land and (predominately) favourable economic variables are complete and positive ($r_s = 1,0$). Therefore, based on the research results, it is established that: the greater the proportion of built land, the greater the population density, the proportions of mature population in the total population, the population with college, university, MA and PhD degree in the total educated population, the economically active (employed and unemployed) population in the total population, the population which lives from independent work in the total population and the proportion of population without income in the total population; and vice versa. On the other hand, the correlations of the proportion of built land and (predominately) unfavourable demographic-economic variables are complete and negative ($r_s = -1,0$). Therefore, based on the research results, it is established that: the greater the proportion of built land, the smaller the proportions of older population in the total population, the economically inactive population in the total population, and the population with income from old-age pension in the total population; and vice versa.

The correlation of the proportion of built land and the proportion of the young in the total population, as well as the proportion of built land and the proportion of the population with elementary and secondary education in the total educated population, are strong and positive ($r_s = 0,8$). Therefore, based on the research results, it is established that: the greater

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the proportion of built land, the greater the proportion of young population in the total population, and the population with elementary and secondary education in the total educated population; and vice versa.

The correlation of the proportion of built land and the proportion of the population without education or with incomplete elementary education in the total educated population, as well as the correlation of the proportion of built land and the proportion of the population with income from agriculture in the total population, are strong and negative (r_s = -0,8). Therefore, based on the research results, it is established that: the greater the proportion of built land, the smaller the proportions of the population without education and with incomplete elementary education in the total population, and smaller the proportion of the population with income from agriculture in the total population; and vice versa.

The aforementioned correlations correspond to the situation in the study area. Young and mature population, which are also economically active, have a higher education degree, earn income from independent work and live in more compact and bigger settlements. However, due to the recently unfavourable economic situation, unemployment rate is high; therefore a large proportion of that population has no income. On the other hand, the old population, economically inactive and with lower education degrees, earn their income from agriculture or old-age pension, and because of this they tend to stay in smaller or sparse settlements.

Forest land

The correlation of the proportion of forest land and the proportion of the population without education or with incomplete elementary education, as well as the correlation of the proportion of forest land and the proportion of the population with income from agriculture in the total population, are strong and positive (r_s = 0,8). Therefore, based on the research results, it is established that: the greater the proportion of forest land, the greater the proportions of the population without education and with incomplete elementary education in the total educated population, and population with income from agriculture in the total population; and vice versa.

The correlation of the proportion of forest land and the proportion young population, as well as the correlation of the proportion of forest land and the proportion of the population with completed elementary and secondary education in the total educated population, are strong and negative (r_s = -0,8). Therefore, based on the research results, it is established that: the greater the proportion of forest land, the smaller the proportions of the young population and population with completed elementary and secondary education in the total educated population; and vice versa.

The aforementioned correlations correspond to the situation in the study area. The estates with forest cover are located in the areas of natural conditions which are unfavourable for human habitation, and in the areas where natural reforestation occurs due to the abandonment of land properties previously used for agriculture. Land abandonment is more frequent in smaller and sparse settlements, characterized by a smaller proportion of young and mature population, and a greater proportion of old population. A small number of people living in that area of small density practice un-modernized agriculture (crop-raising and animal husbandry), and the other part of income earn from old-age pension, which leads to abandonment of their land properties and its natural reforestation.

Dwellings

Based on the correlation results for the land use/land cover variables in question, and variables pertaining to occupied, temporarily occupied and abandoned dwellings in the total number of dwellings for permanent residence, a large number of complete or strong correlations was established.

The correlation of the proportion of occupied dwellings and natural infertile land is complete and negative ($r_s = -1,0$), whereas the correlation of occupied dwellings and the proportion of agricultural land is strong and also negative ($r_s = -0,8$). The correlation of the proportion of temporarily unoccupied dwellings and the proportion of agricultural land is complete and positive ($r_s = 1,0$); the correlation of the proportion of temporarily unoccupied dwellings and the proportion of natural infertile land is strong and also positive ($r_s = 0,8$), whereas the correlation of the proportion of temporarily unoccupied dwellings and the proportion of forest land is strong and negative ($r_s = -0,8$). The correlation of the proportion of abandoned dwellings and the proportion of forest land is strong and positive ($r_s = 0,8$), whereas the negative direction have the correlation of the proportion of abandoned dwellings and the proportion of agricultural land ($r_s = -1,0$), as well as the correlation of the proportion of abandoned dwellings and the proportion of natural infertile land ($r_s = -0,8$).

The aforementioned correlations correspond to the situation in the study area. For a long period of time a large number of working population had been moving out towards the working centres outside of the study area (Pejnović 2004). Predominately old population which had stayed, passed away in the meantime and left behind dwellings and land properties. At least one of the heirs per household still maintains the inherited dwellings and declares them *temporarily unoccupied* dwellings. In addition, heirs also maintain inherited land properties, so that reforestation and the formation of forest land did not occur there. As it is often the case with the study area, the research results showed complete or strong correlation. Therefore, based on the research results, it is established that: the greater the proportion of temporarily unoccupied dwellings, the greater the proportions of agricultural land (this pertains not only to the used land, but also to the total available agricultural land) and natural infertile land, and smaller the proportion of forest land; and vice versa.

The correlation of the proportion of occupied dwellings and the proportion of water surface is complete and positive ($r_s = 1,0$), whereas the correlation of occupied dwellings and the average size of cadastral lot is strong and negative ($r_s = -0,8$). The correlation of the proportion of temporarily unoccupied dwellings and the proportion of water surface is strong and negative ($r_s = -0,8$), whereas the correlation of the proportion of temporarily unoccupied dwellings and the average size of cadastral lot is complete and positive ($r_s = 1,0$). The correlation of the proportion of abandoned dwellings and the proportion of water surface is strong and positive ($r_s = 0,8$), whereas the correlation of the proportion of abandoned dwellings and the average size of cadastral lot is complete and negative ($r_s = -1,0$).

The aforementioned correlations correspond to the situation in the study area. Previously in this paper it is mentioned that a large number of the working population moved out towards the working centres outside of the study area – the reason for this were insufficient opportunities for production-economic basis. On the other hand, population which stayed needed estates with satisfactory production-economic conditions. Among many conditions, their basis is the proximity of water, which offers many advantages:

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greater crop yield of the planted cultures, easier animal watering, the possibility of fishery, fishing, and other. Therefore, based on the research results, it is justifiable to establish that: the greater the proportion of occupied dwellings (of still living population), the greater the proportion of water surfaces; and vice versa. Since on the study area the estates nearby water surfaces have greater value, those who inherited them show a greater interest in their division, for their own benefit. In that case, the size of plots or cadastral lots gets smaller due their partition. Therefore, based on the research results, it is established that: the greater the proportion of occupied dwellings (of still living population), the smaller the average size of a cadastral lot; and vice versa. On the other hand, the owners of the estates further away from water surfaces are those who had moved out (some are still alive because they moved out at working age), or their successors. Since those estates are less valuable, their owners do not have an economic interest in their division, thus fragmentation of those plots or cadastral lots does not take place. Due to the fact that those estates are to a certain point maintained, the final stage of natural reforestation, the formation of forest cover, does not take place. The dwellings are also maintained and declared as *temporarily unoccupied* dwellings. Therefore, based on the research results, it is established that: the greater the proportion of temporarily unoccupied dwellings, the greater the average size of a cadastral lot; and vice versa.

With other pairs of variables in question a weak degree of correlation was established. Their direction corresponds to complete and strong correlations explained beforehand in this paper; in other words, their direction corresponds to the geographical reality of the study area.

CONCLUSION

The research was based on the analysis of the results obtained from calculating the Spearman's rank correlation coefficient (r_s), comprised in the computer program *IBM SPSS Statistics*, version 20. The results of the research established the existence of correlation of all considered pairs of demographic-economic variables and variables pertaining to land use/land cover for the area of Central Lika. A large number of complete and strong correlations established in the research indicates a complete or strong correlation of those pairs of variables, and it is established that they correspond to the geographical reality in the study area.

The results of the research established complete and positive ($r_s = 1,0$) correlations of the proportion of built land and (predominately) favourable demographic-economic variables: the population density, the proportions of mature population in the total population, the population with college, university, MA and PhD degree, the economically active (employed and unemployed) population in the total population, the population which lives from independent work in the total population and the proportion of population without income in the total population. On the other hand, the results established complete and negative ($r_s = -1,0$) correlations of the proportions of built land and (predominately) unfavourable demographic-economic variables: the proportions of older population in the total population, the economically inactive population in the total population, and the population with income from old-age pension in the total population.

The correlation of the proportion of agricultural land and the proportion of temporarily unoccupied dwellings is complete and positive ($r_s = 1,0$), whereas the correlation of the proportion of agricultural land and abandoned dwellings is complete and negative ($r_s = -1,0$).

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The correlation of the natural infertile land and the proportion of occupied dwellings is complete and negative ($r_s = -1,0$). The correlation the proportion of water surface and the proportion of occupied dwellings is complete and positive ($r_s = 1,0$). The correlation of the proportion of temporarily unoccupied dwellings and the average size of cadastral lot is complete and positive ($r_s = 1,0$), whereas the correlation of the proportion of abandoned dwellings and the average size of cadastral lot is complete and negative ($r_s = -1,0$).

A weak correlation of the rest of the considered pairs of variables indicates a weak connection of those pairs of variables. Their direction corresponds to complete and strong correlations; in other words, it corresponds to the geographical reality in the study area.

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