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Differentiation of Administrative Units of Albania by Length and Density of National Road Network

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Abstract: The distribution of the road network in Albania with a total length of about 18,000 km, of which 3794 km are national roads is conditioned by physico-geographic and socio-economic factors. The density of the overall road network is about 630 km/1000 km^2 while that of the national road network is about 130 km/1000 km^2 which is worth ranking Albania in the last group of world rankings, together with Romania and Bulgaria but behind all the Balkan countries. The study assesses and differentiates Albania's national road network based on several statistical indicators, according to the administrative organization (municipalities and districts) approved by law no. 115/2014. The data sources are the road and topographic maps of the scales 1:100000 and 1:200000 as well as the data of the Ministry of Transport and Infrastructure and the Ministry of Local Affairs. Maps and images are georeferenced and processed in ArcGIS 10.2 where digital lines and road junctions and other geographic objects related to them are digitized.

INTRODUCTION

Because of the multi-dimensional functions, the importance of maintaining relationships and achieving integration in every aspect of society, ranging from individual to nation, a compulsory feature of modern life is the transport, movement and exchange of people, goods and services[1]. Roads, widespread as "veins" and "arteries" in all countries of the world, have brought about considerable development[2]. They are an important component of development with complex economic, social and ecological impacts.

Improving transport through road networks leads to increased regional specialization by reducing transport costs. Concentrated economies, not only in large cities but also in rural areas are accelerating their growth, expanding markets and increasing the dominance of the transport system.

The importance of road infrastructure for socio-economic development of a region is already known. In many developing countries, outdated or inefficient transport networks are an expected barrier to economic growth. Many studies have shown that an enhanced and improved road network (e.g., primary,

secondary and tertiary) can provide opportunities for growth and development through: reducing transport, consumption and production costs of goods and services; the increase of agricultural and livestock products through the encouragement of a broader approach and the use of modern inputs; improving access to markets and reducing input prices and agricultural products, etc.

However, the role of the railroad in promoting economic development and spatial transformation is extraordinary. There are a number of empirical studies showing increased land value due to railways in developed and developing countries[3-17].

The road infrastructure in Albania in the technical aspect of the word, began to be built during the First World War when the warring powers located in Albania for their needs built road axes that still exist today. Here, the Austrians are distinguished, who managed to put into operation, also the decauville Shkodra-Vora and Rrogozhina. At the time of King Zog, almost all major cities were connected by roadways which were then paved with the arrival of Italy.

In the years 1945-1992 the development of the road network in Albania was conditioned by specific conditions. Traffic was dominated by large vehicles of transportation of goods where there was no light vehicles of transport while the world experience shows that the heavy traffic ratio with light traffic should be 15-20% with 80-85%. In Albania in the absence of private property on vehicles, this report was the opposite.

Until 1945, the total road network was 2800 km, of which only 400 km were paved. Whereas in 1990, the length of the road network reached 7450 km, of which 2850 km were paved.

Today, there are data that do not entirely match the length of the national road network in Albania. But, according to the Ministry of Transport, currently the Albanian road network has a total length of approximately 18,000 km (Of which 3794 km are defined as national roads). The main road network is about 1796 km long with nine main links making up the base network while the secondary network is 1998 km long.

The linear length of the road, as an important element of human geography and the density of the road network (km/km^2) are critical evaluation indexes to reflect the overall number and level of road construction, often used to control rationality of the distribution of the road network and to verify if the plan/project is correctly balanced. The density of the road network is also one of the decisive factors in the choosing of roads in the generalization of the map.

Road density is a widely useful road network index in a landscape and is also associated with some ecological effects of roads[18, 19]. Road network density analysis is an important method of spatial analysis and is widely used in intelligent transport, urban planning and auto mapping general scenarios. Also, the density of the road network best reflects the dependence of the current transport infrastructure on morphodynamic factors. This indicator reflects the anthropogenic pressures exercised in the natural area[20].

MATERIALS AND METHODS

Brief historical overview of the development of the road network in Albania: The history of the development of the road network in Albania is closely related to the geographic position as a crossroad from East to West and vice versa, the history of our people, its socio-economic relations, the ties that the various provinces of the country had between them and neighboring countries in the Balkans and beyond the Adriatic, the forms of the physical surface of the earth, etc. Albania, not only has a very wide coastal area from Shkodra to Vlora but with the valleys of Drini, Shkumbini, Devoll, Vjosa etc., it is connected with the interior of the Balkans peninsula and hence with the East. Along these valleys in ancient times, the main roads of the country that served both for economic exchanges and as strategic-military roads were developed.

In the antiquity, we highlight the Egnatia road in the valley of Shkumbini which served for economic exchanges between the Adriatic, the Aegean Sea, the Black Sea and the Danube. This road had two starting points: one in Durres and the other in Apollonia. In addition, there were other roads connecting the cities of Illyria such as the road connecting Durrës with Apollonia, the road along the Vjosa valley, the Apoloni-Vlorë-Orikum-Llogara-Finiq-Butrint road Narona-Shkodra-Lezha, Shkodra-Vau i Dejes-Lezha-Durrës, Lezha-Vau i Dejes-Pukë-Kosovo, etc.

In the period between II and XII centuries, the streets and the cities of Albania had more military significance. After the XII century, the character of the streets changed; from the street of strategic importance to the streets of commercial importance. At this time, the old roads gained new significance and new roads were started up to the needs of that time.

With the Turkish occupation, some of the streets and cities were either deserted or lost their importance. Therefore, the streets of our country after the Turkish occupation are nothing more than a continuation of medieval roads. At the end of XVIII century the road network of Albania is expanded; among the

main roads, we can mention: the road Shkodër-Drisht-Shkodër-Pulaj-Shkodër-Lezhë-Lezhë-Orosh-Durrës-Fushë e Tiranës-Dibër the road on Qafë e Kërrabës, Elbasan-Berat-Përmet, Durrës-Vlora, Korça-Kolonjë-Janina, the road along the Vjosa and Drino valleys, etc.

By mid-19th century there was the need to build roads to facilitate relations between the provinces and transport of goods from the coast to internal areas. These paths were mainly strategic goals but also served to link the different provinces between them. Initially, the Turkish administration could only build the Bitola-Korca-Janina road. From end of the XIX century the building of the Urë e Beratit-Përmet Road was also started and several other roads started to be built, starting from the coast harbours to the interior landings. Thus, for example in 1885 measures were taken to start building of Durrës-Tirana road and in 1888 the roads of Shëngjin-Shkodër and Saranda-Janina. But these remained only projects on paper because none was finished. In addition to these roads, other roads were left unfinished and only in a few segments were built and in other segments they never ended. With the creation of the first Albanian state in 1912, Albania inherited from the Turkish rule only 160 km of roads that could be crossed by cart. During the years 1913-1914, the temporary government of Vlora and that of Prince Wid did not do anything for the building of roads. Internal and external entanglements prevented almost any action in this field. During the years 1914-1918, Austro-Hungary, Italy and France, for their military needs, built some roads. Thus the Austro-Hungarian Army reconstructed and built new roads for vehicles [built roads: Shkodër-Vorë, Shkodër-Shirokë, Shkodër-Hani i Hotit, Shkodër-Drisht, Lushnjë-Berat, etc. and reconstructed the roads: Tirana-Durrës and Durrës-Kavaja], some decauvilles [Shkodër-Lezhë-Shengjin with a branch that split at the Buna Bridge and continued to Shiroka; from Lezha the decauville continued to Vora and here it split for Tirana and for Durrës-Kavajë-Rrogozhina and ended at Labinot Bridge at the exit of Elbasan while another branch from Rrogozhina to Lushnja ended in Vjosa and in Berat] and a cable car. When it withdrew from Albania, the Austro-Hungarian army had built a total of 650 km of roads and 450 km of decauville.

Even the Italians built a range of traffic lines for military purposes. Here we mention: Road Vlora-Tepelena-Gjirokastra, Vlora-Llogara-Himara-Saranda with a length of 135, 120 km long decauville network which started from Vlora and had two different lines: one that went to Vlora-Qafe e Koçies down to Shushicë and the second from Vlora which was split again into two branches, one went to the village Panaja and the other in another way but it ended up again in Panaja and 15 small cable cars.

Compared to other provinces, Korca region inherited more roads, so the French who had conquered this province built a few new roads. They built only the roads of Zvezde-Grabovica, Bilisht-Korça, Korça-Voskopoja and Korça-Pogradec.

But the roads and the decauvilles built by Austro-Hungarians, Italians and French at the time of their withdrawal were severely damaged, so again the situation of roads and traffic in Albania deteriorated.

The government that emerged from the Congress of Lushnja took measures and started building new roads such as: Elbasan-Peqin, Pogradec-Qafë Thanë, etc. By 1925 the construction of the roads was made with the funds provided by the national budget and after the coming into force of Ahmet Zogu, their construction was mainly made by borrowing from abroad, by a group of Italian capitalists under the name SVEA (Economic Development of Albania). Many roads were built from this loan: Shkodër-Vau i Dejes-Pukë-Ura e Vezirit, the road Krujë-Qafë Shtamë-Burrel, Tirana-Qafë Kërrabë-Elbasan, Lushnjë-Mrostar as well as many bridges.

At the end of 1938, our country had 2242 km of national roads and 767 km of local roads (on average 80 km per 1000 km^2 of territory). Between 1939 and 1943, the Italian army made some improvements to the road network. Whereas in the period of German invasion there was nothing but destruction of what existed.

In the period 1944-1990 were repaired and built roads of national and local character but that did not correspond to today's European design requirements and standards. By the end of 1990 our country had 16120 km of roads (national, rural and III category) approximately 560 km of roads per 1000 km^2 territory.

After the 90s, studies were conducted on the possibility of developing corridors and transport ramifications in the territory of Albania. Here we mention: Trans-European corridor, West-East (Durres-Tirana-Elbasan-Qafë Thanë-Lin); National North-South corridor (Hani i Hotit-Shkodër-Tirana-Durrës-Rrogozhinë-Fier-Tepelenë-Gjirokastër-Kakavijë); the regional corridor (Durrës-Kukës-Morinë), etc., (Fig. 1). The largest amount of goods and the largest number of passengers circulating in Albania coincides with the direction of these corridors (Fig. 2 and 3).

Some of the aforementioned corridors have been completed and currently, the Albanian road network has a total length of approximately 18,000 km, of which 3794 km are defined as national roads.

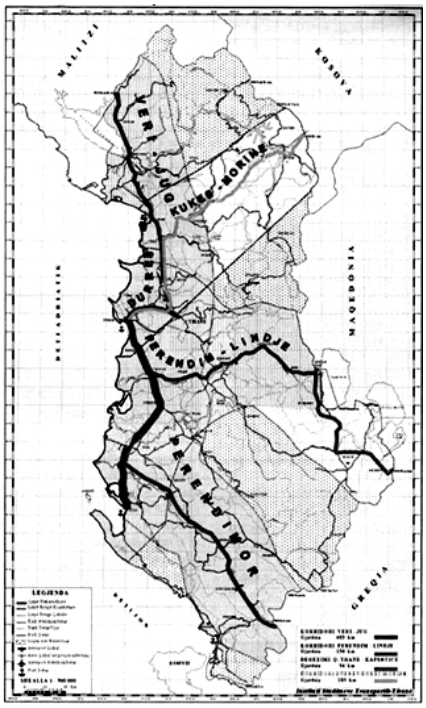

Fig. 1: Main corridors and transport ramifications in the territory of Albania (Source: Revista "Transporti", Nr. 2, viti 2006. IST, Tiranë)

Fig. 2: Goods Movement in the Road Network for 2010 (Thousand Tons/Year), (First Five Years Review of the Albanian National Transport Plan (antp), European Commission Europeaid/127468/c/ser/al Draft Final Report part I June 2010. This project is funded by the European Union. Louis Berger)

Fig. 3: Passenger Traffic in the Road Network for 2010 (number of passengers/day), (First Five Years Review of the Albanian National Transport Plan (antp) European Commission Europeaid/ 127468/c/ser/al Draft Final Report part I June 2010. This project is funded by the European Union. Louis Berger)

RESULTS AND DISCUSSION

Data collection and processing: The study aims to differentiate the administrative units (municipalities and districts) with varying lengths and densities (by surface and by population) of the national road network from the average of the Republic. For this purpose, the data on the surfaces, lengths of national roads and the number of population according to municipalities and counties are collected.

Municipal surface can also be found directly on the "Territorial Reform" page but by analytical analysis and analytical control of the values obtained from this site it turns out that in some cases these surfaces contain errors. Therefore, the surfaces of the municipalities are found through GIS, based on the compensation theory using the relevant map (Fig. 4). Also, from the road network map (Fig. 5), compiled by the Ministry of Transport (Transport Institute), we have extracted the length of the main road network for each municipality, applying GIS technology and the compensation theory

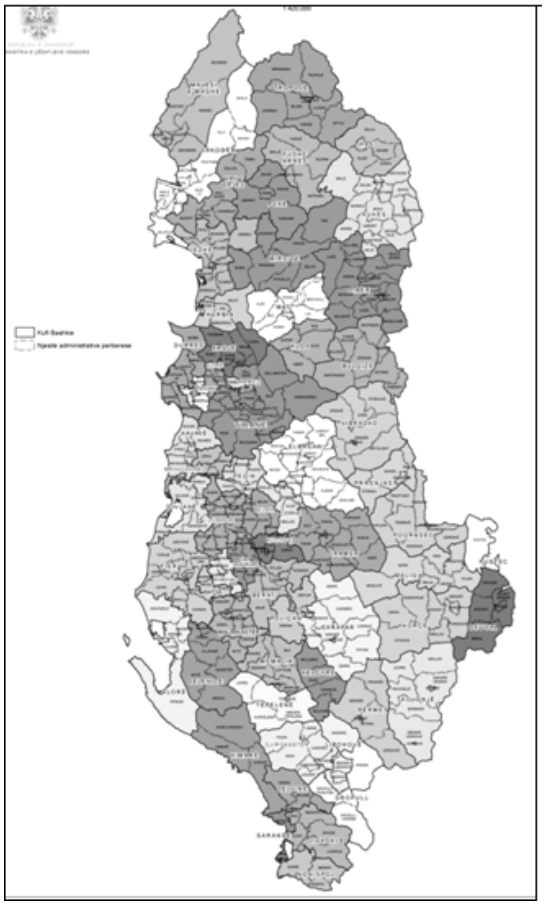

Fig. 4: Administrative division of the Republic of Albania approved by law No.115/2014, road network in the Republic of Albania

that takes into account the lengths of the road network of Albania provided by the Ministry of Transport.

Differentiation of municipalities and counties according to the length of the national road network: Using the above mentioned data, for the differentiation of the national road network of the Republic of Albania by municipalities and districs, we have calculated the average (simple and weighed) and variation indicators (variance, standard deviation, variation coefficient) according to the following Eq. 1.

Simple average Eq. 1:

$$\mu = \left[\sum_{i=1}^{N}(Xi)\right]/N \quad (1)$$

Where:
Xi = Measured/observed values
N = Number of measurements/observations

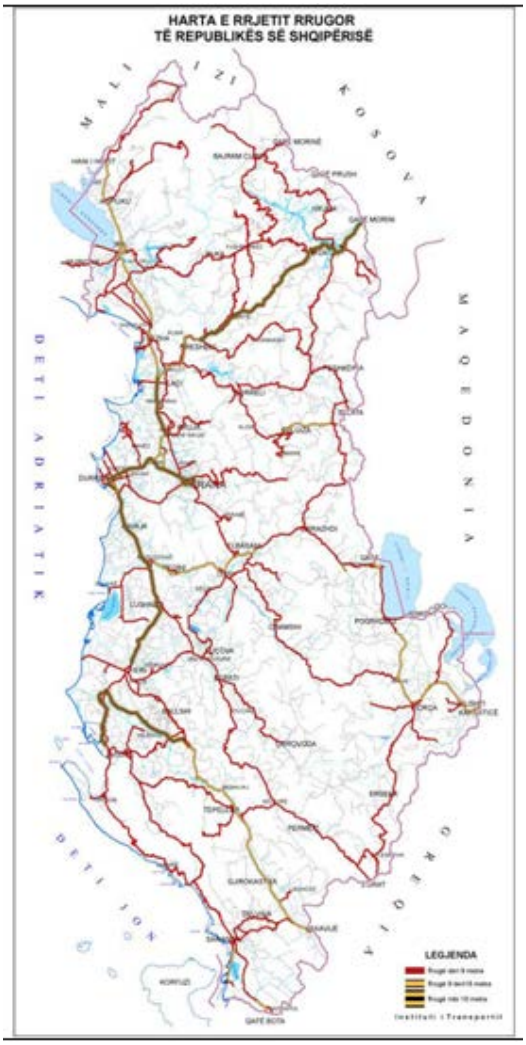

Fig. 5: Road network in the Republic of Albania

Weighted average Eq. 2:

$$\mu = \frac{f_1x_1+f_2x_2+, ..., +f_kx_k}{f_1+f_2+, ..., +f_k} = \frac{\sum f_ix_i}{\sum f_i} \quad (2)$$

Where:
X_i = measured/observed values
f_i = weights of measured/observed values

Mode the observed value that is repeated often during the measurements/observations Eq. 3: When the characteristic values are given at intervals, the mode is calculated by means of the Eq. 3:

$$M_0 = X_0+d\frac{fm_2-fm_1}{(fm_2-fm_1)+(fm_2-fm_3)} \quad (3)$$

Where:
X_0 = The first limit of the interval mode
d = The width of the interval mode
fm_1 = The frequency of the previous interval mode
fm_2 = The frequency range of the mode
fm_3 = The frequency of interval after mode

Mediana Eq. 4 and 5: For even number of surveys/ measurements (4), n-number of surveys/measurements:

$$X_m = \frac{F(n/2)+X(n/2+1)}{2} \quad (4)$$

For odd number of observations Eq. 5, n-number of surveys/measurements:

$$CX_m = \frac{X(n+1)}{2} \quad (5)$$

Variance Eq. 6:

$$Var_{(x)} = \frac{\sum(x_i-\bar{x})}{2} \quad (6)$$

Variation coefficient in % Eq. 7:

$$k_v = \frac{\sqrt{Var(x)}}{\bar{x}} \times 100 \quad (7)$$

Standard deviation Eq. 8:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N}(x_i-\bar{x})}{N}} \quad (8)$$

The correlation coefficient Eq. 9:

$$r = \frac{n\sum xy-\sum x\times\sum y}{\sqrt{\left[n\sum x^2-\left(\sum x\right)^2\right]\left[n\sum y^2-\left(\sum y\right)^2\right]}} \quad (9)$$

Where:
r = Correlation coefficient
x, y = Values of the observed phenomena
n = Sample size

According to the data of 2015 in all of Albania there are 3794 km national roads or for each municipality, aproximately μ = 79.3 km [calculated by weighted average (Eq. 2) where: fi-municipal surface in km^2 and xi- the length of the national road network in km for each municipalit)] with a standard deviation s = 39.4 km (Eq. 8).

For values of the length of the national road system by municipalities, the value between the series (Eq. 5) is Me = 47.1 km (Hasi) and the most frequently repeated value (Eq. 3), Mo = 43.5 km (Shijaku, Gramshi).

Over this average there are 17 municipalities (about 28%); relatively more developed with a larger areas with lower, more flexible or more favorable geographic position (municipalities-regional centers and transit) such as: Pogradec, Bulqizë, Vau i Dejës, Lushnjë, Himarë, Selenicë, Dibër, Vlorë, Malësia e Madhe, Tropojë, Shkodra, Mirditë, Kukës, Fier, Lezhë, Elbasan dhe Tiranë. About 72% of the municipalities (Vorë, UraVajgurore, Roskovec, Rrogozhinë, Kavaja, Libohova, Pustec, Patos, Kamza, Perrenjas, Belsh, Peqin, Sarandë, Cërrik, Delvinë, Dropull, Skrapar, Berat, Kuçovë, Gjirokastër, Kurbin, Klos, Kelcyra, Shijak, Gramsh, Memaliaj, Konispol, Puka, Has, Përmet, Maliq, Livadhja/Finiq, Divjaka, Mat, Librazhd, Devoll, Durrës, Mallakastra, Korça, Kolonjë, Fushë Arrës, Tepelena and Kruja) have a length of the national road network less than the average of the Republic of Albania.

Differentiation of municipalities according to the length of the national road network and standard deviation is based on the statistical theory.

Thus, according to this theory, we distinguish the municipalities with the length of the road network: significantly below the average, those with less than (μ-s) km (<39.9 km); below the average, those with more than (μ-s) km and less than (μ) km (39.9 km÷79.3 km); above the average, those with more than (μ) km and less than (μ+s) km (79.3 km÷118.7 km) and significantly above the average, those with more than (μ+s) km (>118.7 km) Table 1.

Currently in all Albania there is an average of μ = 332.4 km national roads for each district (calculated by weighted average where: fi-surface of districts in km^2 and xi-lengths of national road network in km for each district) with a standard deviation s = 89.7 km. Above this average there are 5 districts (about 42%) such as: Elbasan, Korça, Fier, Shkodra and Vlora. About 58% of the districts (Berat, Durrës, Tirana, Debar, Gjirokastra, Kukës and Lezha) have a national road length less than the average of the Republic.

In analogy with the differentiation of municipalities in Table 2 is given the differentiation of the districts according to the length of the national road network and the standard deviation. Districts with the length of the national road network: significantly below the average, those with <(μ-s) km (<242.7 km); below the average, those with >(μ-s) km and <(μ) km (242.7 km÷332.4 km); above the average, those with >(μ) km and <(μ+s) km (332.4÷422.1 km) and significantly above the average, those with >(μ+s) km (>422.1 km).

Depending on the geographical position, the size of the urban center and the degree of economic development depend on the number of regional and national roads that join in the urban center and cross the territory of the municipality.

Table 1: Differentiation of municipalities according to the length of the national road network and standard deviation

Interval	Designation	Municipalities
<39.9 km	Municipalities with length of the national road network "significantly below the average" 22 (36%)	Vore, Ura Vajgurorë, Roskovec, Rrogozhinë, Kavajë, Libohovë, Pustec, Patos, Kamzë, Perrenjas, Belsh, Peqin, Sarandë, Cërrik, Delvinë, Dropull, Skrapar, Berat, Kuçovë, Gjirokastër, Kurbin, Poliçan
39.9-79.3 km	Municipalities with length of the national road network "below the average" 22 (36%)	Klos, Këlcyrë, Shijak, Gramsh, Memaliaj, Konispol, Pukë, Has, Përmet, Maliq, Livadhja/Finiq, Divjakë, Mat, Librazhd, Devoll, Durres, Mallakastër, Korcë, Kolonjë, Fushë Arrë s, Tepelenë, Krujë
79.3-118.7 km	Municipalities with length of national road network "above the average" 11 (18%)	Pogradec, Bulqizë, Vaui Dejë s, Lushnjë, Himarë, Selenicë, Dibër, Vlorë, Malesiaë Madhë, Tropojë, Shkodra
Over 118.7 km	Municipalities with length of the national road network "significantly above the average" 6 (10%)	Mirditë, Kukë s, Fier, Lezhë, Elbasan, Tiranë

Table 2: Differentiation of districts according to the length of the national road network and standard deviation

Interval	Designation	Municipalities
With <242.7 km	Circuits with length of the national road network "significantly below the average" 2 (about 17%)	Berat, Durres
With 242.7-332.4 km	Districts with length of the national road network "below the average" 5 (about 41%)	Tiranë, Dibër, Gjirokastër, Kukës, Lezhë
With 332.4-422.1 km	Districts with length of national road network "above the average" 3 (about 25%)	Elbasan, Korçë, Fier
With above 422.1 km	Districts with length of the national road network "significantly above the average" 2 (about 17%)	Shkodër, Vlorë

Table 3: Differentiation of municipalities according to the density of the national road network and standard deviation

Interval	Designation	Municipalities
With <56.51000 km^2	Municipalities with density of the national road system significantly below the average (1.6%)	Skrapar
56.5-151.3 km/1000 km^2	Municipalities with density of the national road system below average (64%)	Gramsh, Kavajë, Dropull, Përrenjas, Librazhd, Përmet, Maliq, Libohovë, Kolonjë, Gjirokastër, Korçë, Berat, Pukë, Ura Vajgurore, Rrogozhinë, Pustec, Dibër, Tropojë, Klos, Mat, Has, Peqin, Malësia e Madhe, Memaliaj, Belsh, Bulqizë, Delvinë, Roskovec, Këlcyrë, Pogradec, Shkodra, Fushë Arrës, Livadhja/Finiq, Kukës, Cërrik, Devoll, Mirditë, Kurbin, Poliçan
151.3-246.1 km/1000 km^2	Municipalities with density of national road system above the average (26.2%)	Himarë, Vorë, Tiranë, Vau i Dejës, Selenicë, Tepelenë, Elbasan, Vlorë, Konispol, Divjakë, Durrës, Mallakastër, Fier, Kuçovë, Krujë, Lushnjë
With <246.1 km km^{-2}	Municipalities with density of the national road system significantly above average (8.2%)	Patos, Lezhë, Sarandë, Shijak, Kamzë

Differentiation of municipalities and districts according to the density of the national road network in relation to the area: Even for this type of differentiation, statistical indicators were used, calculated according to Eq. 1-9 utilizing data on the density of the national road network for each municipality and district.

According to the data of 2015 in all of Albania there is an average μ = 151.3 km/1000 km^2 national road per municipality (calculated by simple mean (Eq. 1)] with a standard deviation s = 94.8 km/1000 km^2 above this average there are 21 municipalities (about 34.4%) such as: Himarë, Vorë, Tirana, Vau i Dejës, Selenicë, Tepelenë, Elbasan, Vlorë, Konispol, Divjakë, Durrës, Mallakastër, Fier, Kuçovë, Krujë, Lushnjë, Patos, Lezhë, Saranda, Shijak and Kamza.

From the differentiation of the municipalities according to the density of the national road network to the surface and the standard deviation, we distinguish the municipalities with density of the road network: significantly below the average, those with less than (μ-s) km/1000 km^2 (<56.5 km/1000 km^2) ; below the average, those with more than (μ-s) km/1000 km^2 and less than (μ) km/1000 km^2 (56.5-151.3 km/1000 km^2); above the average, those with more than (μ) km/1000 km^2 and less than (μ+s) km/1000 km^2 (151.3 - 246.1 km/1000 km^2) and significantly above the average, s) km/1000 km^2 (>246.1 km/1000 km^2)[1] (Table 3).

Currently in all of Albania there is an average of μ = 138.6 km/1000 km^2 national road for each district [calculated by simple mean] with a standard deviation s = 47.3 km/1000 km^2. Above this average there are 5 districts (about 41.65%) such as Lezha, Tirana, Vlora, Durrës and Fier.

By analogy with the differentiation of municipalities in Overview 4 is given the differentiation of the districts according to the density of the national road network and the standard deviation. Municipalities with road network densities: significantly below the average, those with <(μ-s) km/1000 km^2 (<91.3 km/1000 km^2); below the average, those with >(μ-s) km/1000 km^2 and <(μ) km/1000 km^2 (91.3 km/1000 km^2÷138.6 km/1000 km^2);

Table 4: Differentiation of districts according to the density of the national road network and standard deviation

Interval	Designation	Districts
With <91.3 km/1000 km^2	Municipalities with density of national road network significantly below average (8:35%)	Berat
91.3-138.6 km/1000 km^2	Municipalities with density of national road network below average (50%)	Dibër, Elbasan, Gjirokastër, Korçë, Kukës, Shkodër
138.6-185.9 km/1000 km^2	Districts with density of national road network above the average (25%)	Lezhë, Tiranë, Vlorë
With <185.9 km km^{-2}	Districts with density of national road network significantly above average (16.65%)	Durrës, Fier

Table 5: Differentiation of municipalities according to the density of the national road network in relation to population and standard deviation

Interval	Designation	Municipalities
With <28.7 km/10000 inhabitants	Municipalities with density of the national road network below the average (70%)	Vorë, Kamzë, Tiranë, Durrës, Kavajë, Berat, Ura Vajgurore, Roskovec, Rrogozhinë, Kurbin, Shkodër, Korçë, Peqin, Përrenjas, Patos, Cërrik, Lushnje, Vlorë, Elbasan, Fier, Kuçovë, Belsh, Sarandë, Maliq, Shijak, Pogradec, Krujë, Gjirokastër, Divjakë, Dibër, Gramsh, Librazhd, Lezhë, Mat, Skrapar, Devoll, Klos, Mallakastër, Bulqizë, Kukës, Vau-Dejës, Has
28.7-57.5 km/10000 inhabitants	Municipalities with density of the national road network above the average (11.5%)	Poliçan, Delvinë, M. e Madhe, Memaliaj, Pukë, Përmet, Finiq
With >57.5 km/10000 inhabitants	The municipalities with density of the national road network significantly above the average (19.5%)	Selenicë, Konispol, Libohovë, Mirditë, Tropojë, Kolonjë, Pustec, Këlcyrë, Dropull, Tepelenë, F.-Arrës, Himarë

Table 6: Differentiation of districts according to density of the national road network in relation to population and standard deviation

Interval	Designation	Districts
With <7.4 km/10000 inhabitants	Districts with density of national road network significantly below the average (16.7%)	Tiranë, Durrës
7.4-11.5 km/10000 inhabitants	Districts with density of national road network below the average (8.3%)	Berat
11.5-30.4 km/10000 banorë	Districts with density of national road network above the average (58.3%)	Elbasan, Fier, Korçë, Shkodër, Dibër, Lezhë, Vlorë
With >30.4 km/10000 inhabitants	Districts with density of the national road network significantly above average (16.7%)	Kukës, Gjirokastër

above the average, those with <(μ) km/1000 km^2 and <(μ+s) km/1000 km^2 (138.6 km/1000 km^2÷185.9 km/1000 km^2) and significantly above the average, those with more is (μ+s) km/1000 km^2 (>185.9 km/1000 km^2) (Table 4).

Differentiation of municipalities and districts according to the density of national road network in relation to the population: In order to realize this kind of differentiation of municipalities and districts, the density of the national road network to the population was calculated with the Eq. 10:

$$D = [L*10000]/P \quad (10)$$

Where:
L = Length of road network in km
P = Number of population

According to the data of 2014 in all of Albania there were averagely μ = 57.5 km/10000 national road per municipality (calculated by simple average) with a standard deviation s = 28.8 km/10000 inhabitants. Over this average there are 12 municipalities (about 19.5%) such as Selenica, Konispol, Libohova, Mirdita, Tropoja, Kolonja, Pustec, Këlcyra, Dropull, Tepelena, Fushë Arrës and Himara (Table 5).

From the differentiation of the municipalities according to the density of the national road network in relation to the population and the standard deviation, we distinguish the municipalities with density of the national road network in relation to the population: significantly below the average, those with less 28.7 km/10000 inhabitants; below the average, those with 28.7 km/10000 inhabitants÷57.5 km/10000 inhabitants; above the average, those with 57.5 km/10000 inhabitants÷86.3 km/10000 inhabitants and significantly above the average, those with more than 86.3 km/10000 inhabitants (Fig. 5).

By analogy with the differentiation of municipalities in Overview 6, the differentiation of districts according to density of the national road network in relation to the population and the standard deviation (μ = 11.5 km/10000 inhabitants and s = 4.1 km/10000 inhabitants).

Above the average of the Republic μ = 11.5 km/10000 inhabitants, there are 9 districts or 75% of the total number of districts. The districts of Tirana, Durrës and Berat have the density of the national road network in relation to the number of population, lower than the average of the Republic of Albania (Table 6).

Differentiation of municipalities and districts according to the density of the national road network in relation to surface and population. Correlation

analysis: By statistical processing it rezults that 41.5% of the total number of municipalities (Kavaja Berat, Ura Vajgurore, Roskovec, Rrogozhinë, Kurbin, Shkoder, Korce, Peqin, Përrenjas, Cërrik, Belsh, Maliq, Pogradec, Gjirokastra, Dibra, Gramsh, Librazhd, Mat, Skrapar, Devoll, Klos, Bulqiza, Kukës, Has) have the density of the national road network (in relation to the surface and the population), "significantly below average" and "below average" of the Republic.

Berat is the district with density of national road network (by surface area and population), "below average" while Tirana and Durres are districts with density of national road network (per population) "significantly below average" of the Republic.

For more specialized analyzes, we have put in report the values for the surface of the municipalities and the length of the national road network within them.

The value of the coefficient of correlation (r = 0.7748, calculated according to Eq. 9 indicates a considerable positive relation between the surfaces of the municipalities and the length of the national road network within them which means that in municipalities with larger surface area, the length of the road is greater, provided that relief is field-hilly and with valleys.

The regression coefficient in the Eq. Y = 10.277+0.108 X, shows that, theoretically with the increase of surface per 100 km^2, the length of the national road network increases by 10.8 km.

We have also mapped the values for the population of the municipalities and the length of the national road network within them. The value of the correlation coefficient (r = 0.5295) indicates a somewhat strong relation between the number of population and the length of the national road network in the municipality.

CONCLUSION

The density of the overall road network is about 630 km/1000 km^2 while the density of the national road network is about 130 km/1000 km^2, ranking Albania in the last group of classification at world level such as Romania and Bulgaria but behind all the Balkan countries.

There are on average 79.3 km of national roads per city and 332.4 km of national roads for each district in all of Albania. Above the average, there are 17 municipalities (28%), among which, 6 municipalities (10%) have a national road network "significantly above average"] and 5 districts (42%) such as Elbasan, Korca, Fier, Shkodra and Vlora. While below average, there are 44 municipalities (72%), of which 22 municipalities (36%) have a national road network "significantly below average"] and 7 districts (58%) such as Berat, Durrës, Tirana, Dibra, Gjirokastra, Kukës and Lezha. Also in all of Albania, there is an average of 151.3 km/1000 km^2 national road per city with a standard deviation of 94.8 km/1000 km^2 and 138.6 km/1000 km^2 national road for each district with a standard deviation of 47.3 km/1000 km^2. Above average there are 21 municipalities (about 34.4%) [Himarë, Vorë, Tirana, Vau i Dejes, Selenica, Tepelena, Elbasan, Vlorë, Konispol, Divjaka, Durrës, Mallakastra, Fier, Kuçovë, Krujë, Lushnjë, Patos, Lezhë, Sarandë, Shijak and Kamza] and 5 districts (about 41.65%) (Lezha, Tirana, Vlora, Durrës and Fier).

For each municipality there are an average of 57.5 km/10000 inhabitants with a standard deviation of 28.8 km/10000 inhabitants while for each district there are an average of 11.5 km/10000 inhabitants. Above this average there are 12 municipalities (about 19.5%) (Selenica, Konispol, Libohova, Mirdita, Tropoja, Kolonja, Pustec, Këlcyra, Dropull, Tepelena, F.-Arrës and Himara) and 9 districts or 75% of the total number of districts. The districts of Tirana, Durrës and Berat have density of the national road network in relation to the number of population, lower than the average of the Republic.

Municipalities with density of road network (in relation to surface and population), "significantly below average" and "below average", account for about 41.5% of their total number [Kavaja, Berat, Ura Vajgurore, Roskovec, Rrogozhina, Kurbin, Shkodër, Korçë, Peqin, Perrenjas, Cërrik, Belsh, Maliq, Pogradec, Gjirokastër, Debar, Gramsh, Librazhd, Mat, Skrapar, Devoll, Klos, Bulqizë, Kukës, Has]. Berat is the district with density of road network (by surface and population) "below average" while Tirana and Durres are districts with density of road networks (by population) "significantly below average".

The correlation coefficient value (r = 0.7748) indicates a significant positive correlation between the areas of the municipalities and the length of the national road network within their boundaries, provided that the relief is field-hilly and with valleys. Likewise, the value of the correlation coefficient (r = 0.5295) indicates a somewhat strong relation between the number of population and the length of the national road network in the municipality.

Analysis of statistical indicators shows that the distribution of the national road network in the Republic of Albania is not uniform. This is conditioned by physical-geographic and socio-economic factors. Uneven development of the transport network is one of the strongest reasons for the uneven economic development of the various provinces of the country. There is a rigorous proportional relationship between the poverty rate and the level of infrastructure quality. For this, the northern and northeastern parts of the country can be taken as an example. Insufficient road infrastructure is also a major cause for high levels of pollution in

urban areas. Typical example for this is the city of Tirana where the concentration of construction and infrastructure development within the small roundabout has caused pollution levels up to ten times higher than the norm.

In the future, care should be taken to increase the length of the national road network to 41.5% of municipalities (Kavaja, Berat, Ura Vajgurore, Roskovec, Rrogozhina, Kurbin, Shkodra, Korça, Peqin, Perrenjas, Cerrik, Belsh, Maliq, Pogradec, Gjirokastra, Dibra, Gramsh, Librazhd, Mat, Skrapar, Devoll, Klos, Bulqiza, Kukës, Has) and in 25% of the districts (Tirana, Durrës and Berat).

SUMMARY

Albanian road network has a total length of approximately 18000 km., of which 3794 km are classified as national roads. The distribution of this road network is different and depends on the physical and geographical factors and socio-economic factors. The density of total road network is about 630 km/1000 km^2 while the density of the national road network is about 130 km/1000 km^2, value that ranks Albania in the last group of global classification together with Romania and Bulgaria but after all Balkan countries.

Based on some statistical indicators, the study assesses and classifies Albania's national road network according to administrative organization (municipalities and counties) approved by Law no. 115/2014. Data sources are road maps and topographic maps at scales 1: 100,000 and 1: 200,000 and the data received by the Ministry of Transport and Infrastructure and the Ministry of Local Government. Maps and images are processed in ArcGIS 10.2 where are digitized road nodes and lines and other geographic objects associated with the road network.

Each municipality has an average 79.3 km of national road (151.3 km/1000 km^2 with a standard deviation 94.8 km/1000 km^2 and 57.5 km/10000 inhabitants with a standard deviation 28.8 km/10,000 inhabitants) while each county has an average 332.4 km of road national (138.6 km/1000 km^2 with a standard deviation 47.3 km/1000 km^2 and 11.5 km/10,000 inhabitants). Over the average there are 17 municipalities (28%) (Among which 6 municipalities (10%) have a length of the national road network “significantly above average”) and 5 counties (42%). While under this average there are 44 municipalities (72%) (Among which 22 municipalities (36%) have a length of the national road network “significantly under average”) and 7 counties (58%) (Berat, Durres, Tirana, Dibër, Gjirokastra and Lezha, among which Berat and Durres have a length of the national road network “significantly below average”).

Approximately 41.5% of the total number of municipalities (Kavajë, Berat, Ura Vajgurore, Roskovec, Rrogozhinë, Kurbin, Shkodër, Korçë, Peqin, Prrenjas, Cërrik, Belsh, Maliq, Pogradec, Gjirokaster, Dibër, Gramsh, Librazhd, Mat, Skrapar, Devoll, Klos, Bulqizë, Kukës, Has) have the density of the national road network (related to the surface and the population), “significantly below average” and “below average” of the Albania. Berat county has national road network density (related to the surface and the population) “below average” while the Tirana county and Durres county has road network density (related to the population) “significantly below average” of Albania.

The unequal development of the road network is one of the strongest reasons for the unequal economic development of different regions of Albania. Inadequacy of road infrastructure is also a major cause for the high level of pollution in urban areas.

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