THE ACCESSIBILITY IN NETWORK. CASE STUDY: ATU GĂGĂUZIA

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Rezumat: *Mişcarea populaţiei este unul din factorii determinativi ai vieţii societăţii. Reducerea consumului de timp şi distanţe inutile au fost şi sunt una din tendinţele principale în dezvoltarea societăţii. Accesibilitatea populaţiei este determinată în mare parte de căile de acces către servicii sau către alte obiective ce asigură buna vieţuire a oamenilor (accesibilitatea către serviciile medicale, pompieri, la justiţie, poliţie, pieţe de desfacere, instituţii de învăţământ etc.).*

Se analizează reţeaua de transport rutier din Unitatea Teritorial Autonomă Găgăuzia, care include măsurătorile de distanţe; formarea rutelor intre localităţile unităţii administrative şi centrul administrativ, ca prestator a majorităţii serviciilor, formarea zonelor de accesibilitate (prin isochrone); determinarea densităţii reţelei rutiere pe comune etc.

Key words: *road network, accessibility, access zones, network density, isochrones.*

Introduction

This study comes to complete the investigation started for the assessment and the measurement of transport networks in administrative districts of the Republic of Moldova. It is tried to identify the GIS processes for measuring the capacity and structure of networks of the same kind as the content and theme. The networks of any type can be caracterized by size, location, structure, connectivity, pressure on its structural elements etc.

In the south of the country there are located two territorial-administrative units - Cahul and Autonomous Territorial Unit of Gagauzia (ATUG). The road network of Cahul Unit was the subject of a research in wich several network indicators were analyzed as time and distances in the network, the level of accessibility from and to the administrative center etc. (Mamot, 2008).

The Autonomous Territorial Unit of Gagauzia (ATUG) is located in the south-east of Moldova, holding an area of over 1 832 sq km. This unit includes 33 localities with a population of 155 646 inhabitants. ATUG includes three administrative districts – Comrat, Ciadar-Lunga and Vulcanesti.

The form and content of the transport network is determined by the geographical position of the administrative unit. Gagauzia represebts a structure of five territorial components, disconnected from each other. This division is largely

due to the ethnic structure of the component localities. In most localities, only a few exceptions, the majority population is represented by the Gagauz.

The main road arteries mostly repeat the directions on wich the ATUG territories stretch. The most important roads are: **Road M-3** that connects the southern country (*Giurgiulesti* customs) with Chisinau, but less used on the *Cimislia-Chisinau* section for technical reasons. This road partly passes the ATUG's territory. It plays the role of transport collector from the dispersed territories of Gagauzia; **Road R-36** – links Cazaclia locality with Cioc-Maidan commune through eastern extremity; **Road R-37** – collects the transport flow on the south-east – north-west directionfrom Comrat and Ciadar-Lunga districts; **Road R-35** unites Cioc-Maidan commune with Comrat town.

The extension and structure of ATUG determine different levels of accessibility by the population of the services like justice, firefighters, medical emergency service etc., usually offered in district centres. The study considered the fact that most facilities are located in administrative centre of ATUG – Comrat town.

The accessibility taken as a basis for analysis and intervention influences directly the sustainable local development. The accessibility determines the costs that population consumes to reach objects and realize activities in geographic space (Burns, 1979; Miller, 1999; Rodrigue et all, 2009). The accessibility is one of the ensurance premises of population's necessity in facilities. Starting from the idea that the transport's role is to insure the connection between the localities and the good markets' functioning, there exists a high potential for using the models of accessibility with reference to economic sectors and domains (electroenergetics, education, justice, health, sales markets, agriculture, labour market etc.).

Methods and Materials As a research support the transport network of ATUG was digitized by 1:50 000 topographic maps. For a spatial analysis it was constructed a geometrical network of roads of all categories in district boundaries.

Table1 Length and time indicators in the automobile road network of ATU Gagauzia											
	All road categories		Categories 1-2		Category 3		Category 5		Category 6		Category 10	
COMMUNES	LENGTH (km)	DENSITY (km2)	LENGTH (km)	DENSITY (km2)	LENGTH (km)	DENSITY (km2)	LENGTH (km)	DENSITY (km2)	LENGTH (km)	DENSITY (km2)	LENGTH (km)	DENSITY (km2)
Ceadar-Lunga	254	2,64	44	0,45	125	1,31	10	0,11	56	0,59	18	0,19
Avdarma	153	2,32	6	0,09	109	1,65	2	0,03	23	0,35	13	0,20
Baurci	213	2,78	9	0,11	151	1,98	6	0,08	33	0,43	14	0,18
Besalma	131	2,15	12	0,20	88	1,44	5	0,08	22	0,36	4	0,07
Besghioz	109	2,06	11	0,21	74	1,41	3	0,06	13	0,25	7	0,14
Bugeac	34	1,86	5	0,26	21	1,17	2	0,11	4	0,22	2	0,10
Cazaclia	241	2,25	13	0,12	170	1,58	8	0,07	29	0,27	22	0,21
Chiriet-Lunga	139	2,37	15	0,25	102	1,74	2	0,03	18	0,31	2	0,04
Chirsova	210	2,04	10	0,10	163	1,59	4	0,04	29	0,29	3	0,03
Cioc-Maidan	155	2,03	12	0,16	98	1,29	7	0,09	30	0,39	8	0,10
Congazcicul de Sus	115	2,73	13	0,31	82	1,94	3	0,07	9	0,22	8	0,19
Copceac	232	2,22	16	0,16	167	1,60	6	0,06	36	0,34	7	0,06
Cotovscoe	29	1,86	2	0,13	23	1,47	1	0,09	3	0,16	**0**	**0,00**
Dezghingea	226	2,27	8	0,08	169	1,70	9	0,09	35	0,35	5	0,05
Ferapontievca	71	2,15	8	0,23	51	1,54	3	0,10	9	0,28	**0**	**0,00**
Gaidar	121	2,42	13	0,26	77	1,53	4	0,07	15	0,30	12	0,25
Joltai	76	2,11	7	0,18	51	1,43	2	0,05	11	0,31	5	0,14
Tomai	146	1,84	17	0,21	93	1,16	4	0,05	17	0,21	16	0,20
Vulcanesti	394	2,59	51	0,34	230	1,51	13	0,08	62	0,41	**37**	0,24
Cismichioi	229	2,43	23	0,24	142	1,51	10	0,11	40	0,42	14	0,15
Etulia	113	**1,83**	14	0,23	76	1,22	5	0,07	12	0,19	7	0,11
Etulia	0	2,53	0	2,53	**0**	**0,00**	**0**	**0,00**	**0**	**0,00**	**0**	**0,00**
Chioselia Rusa	27	2,79	5	0,54	12	1,26	2	**0,25**	4	0,39	3	0,35
Svetlii	59	2,66	6	0,26	43	1,92	1	0,05	10	0,44	**0**	**0,00**
Congaz	271	2,09	28	0,22	175	1,35	7	0,05	42	0,32	19	0,15
mun.Comrat	**421**	2,50	**57**	0,34	**275**	1,63	**14**	0,08	**73**	0,44	1	0,01
Carbalia	42	3,06	**0**	**0,01**	30	**2,17**	1	0,09	6	0,44	5	**0,35**
Carbalia	2	**8,03**	**0**	2,34	**0**	**0,00**	**0**	**0,00**	1	**5,69**	**0**	**0,00**
TOTAL	**4 213**	70,60	**404**	10,55	**2 800**	40,13	**135**	2,08	**640**	14,34	**233**	3,50
AVERAGE		**2,52**		**0,38**		**1,43**		**0,07**		**0,51**		**0,13**

The network is a vector set af data, represented by nodes interconnected by lines.As nodes can serve localities, facilities, road intersections etc.

For a proper functioning of the network in the GIS system there was worked on the formation of a corect topology. The topology supposed to „teach" the network to function as an integral whole. Minor segment errors generate significant errors throughout the whole network, in our case the the road network.

For graphical data a base of attributes was created, which included noy only names and categories of the roads, but also the following information: administrative belonging, road categories by quality, distance, time, nodes, crossing directions, bridges, closed roads, asphalted and unasphalted roads etc (Butler, 2008). As a result it was constructed a network with 4 856 nodes and 11 898 arcs.

Table 2 Length and time indicators regarding ATUG population accessibility to the administrative centre (Comrat)											
	STRAIGHT LINES DISTANCE		ROUTES					AVERAGE SPEED	DIFFERENCE COMPARED TO STRAIGHT LINES		ROUTE SINUOSITY COEFFICIENT
Locality	Meters	Km	Nr. route	Minutes	Hours	Meters	Km	Km\h	Meters	Km	
Alexeevca	31069	31,069	24	41	0,68	32148	32,148	47	1 079	1,079	0,97
Avdarma	14634	14,634	23	19	0,31	17298	17,298	55	2 664	2,664	0,85
Baurci	22340	22,340	1	57	0,95	26341	26,341	**28**	4 001	4,001	0,85
Besalma	14552	14,552	13	22	0,36	16073	16,073	44	1 521	1,521	0,91
Besghioz	25532	25,532	4	53	0,88	35380	35,380	40	9 848	9,848	0,72
Bugeac	7571	7,571	11	12	0,20	8215	8,215	41	644	0,644	0,92
Carbalia	49809	49,809	8	102	1,70	57704	57,704	34	7 895	7,895	0,86
Cazaclia	31666	31,666	3	78	1,31	36424	36,424	28	4 757	4,757	0,87
Ceadir-Lunga	30334	30,334	31	43	0,71	35772	35,772	50	5 439	5,439	0,85
Chioselia Rusa	25833	25,833	19	42	0,71	30029	30,029	42	4 196	4,196	0,86
Chiriet-Lunga	23802	23,802	21	29	0,49	27015	27,015	55	3 213	3,213	0,88
Chirsova	**6452**	**6,452**	14	**9**	**0,15**	**6498**	**6,498**	42	**46**	**0,046**	**0,99**
Cioc-Maidan	14295	14,295	22	15	0,25	15398	15,398	**61**	1 103	1,103	0,93
Cismichioi	86023	86,023	17	125	2,09	94199	94,199	45	8 176	8,176	0,91

Congaz	21060	21,060	16	27	0,45	21236	21,236	48	176	0,176	0,99
Congazcicul de Jos	6819	6,819	20	13	0,21	7290	7,290	34	471	0,471	0,94
Congazcicul de Sus	8078	8,078	25	15	0,26	9526	9,526	37	1 448	1,448	0,85
Copceac	49415	49,415	7	104	1,73	56568	56,568	33	7 153	7,153	0,87
Cotovscoe	18670	18,670	12	42	0,70	32050	32,050	46	13 380	13,380	**0,58**
Dermengi	49798	49,798	29	119	1,98	63666	63,666	32	**13 868**	**13,868**	0,78
Dezghingea	14608	14,608	10	23	0,38	15895	15,895	42	1 287	1,287	0,92
Dudulesti	11473	11,473	27	19	0,31	13199	13,199	43	1 725	1,725	0,87
Etulia	86036	86,036	18	121	2,01	92541	92,541	46	6 504	6,504	0,93
Etulia Noua	**88322**	**88,322**	26	**126**	**2,10**	**95181**	**95,181**	45	6 859	6,859	0,93
Ferapontievca	11294	11,294	15	14	0,23	12566	12,566	54	1 272	1,272	0,90
Gaidar	22734	22,734	2	43	0,72	28526	28,526	40	5 792	5,792	0,80
Joltai	21045	21,045	6	38	0,63	27670	27,670	44	6 625	6,625	0,76
Svetlii	31968	31,968	9	41	0,68	32647	32,647	48	678	0,678	0,98
Tomai	14646	14,646	5	23	0,39	17959	17,959	46	3 313	3,313	0,82
Vulcanesti	70701	70,701	30	94	1,57	79685	79,685	51	8 984	8,984	0,89
SUM	**910581,0**	**910,6**	**30,0**	**1508,4**	**25,1**	**1044700,3**	**1044,7**	**1302,4**	**134119,3**	**134,1**	**26,2**
AVERAGE	**30352,7**	**30,4**		**50,3**	**0,8**	**34823,3**	**34,8**	**43,4**	**4470,6**	**4,5**	**0,9**

The highlighting of roads categories started with the idea of accessibility, level of use, content and structure of the road. Six road categories were distinguished (Table 1, fig.1). Most important for both economy and population are the following categories:

1.*Improved asphalted roads,*

2. *Asphalted roads,*

3.*Paths and country roads,*

4.*Central roads in localities,*

5.*Secondary roads in localities,*

6.*Local unasphalted roads.*

The third category provides the accessibility of the population only inside the communes' territories. GIS softwares (TransCad 4.5 and ArcGIS 9.1, extension Network Analyst) were used as tools for the analysis of space and accessibility level.

Results and Comments

The density of road network.

In the first step it was determined the assurance degree with roads of all categories by calculating the transport network density for an administrative unit's communes. The highest density of roads of all categories is registered in *Carbalia* commune (8,03 km/km^2), *Carbalia* village (3,06 km/km^2) and *Comrat* municipium (2,79 km/km^2). In twenty-two localities the values of road density are recorded between 2 and 3 km/km2. In the remaining localities the values fall within 1-2 km/km2 (fig.1, Table1). The road density indices by a category in part repeat the indices with the reference to the density for all road categories.

Table 3. Distribution of population by zones of 10 km			
Buffer Zones	Frequency	Population (hab.)	Population(%)
0-10	5	33984	21,8
10-20	8	19705	12,7
20-30	7	34456	22,1
30-40	4	30991	19,9
40-50	3	10119	6,5
60-70	1	267	0,2
70-80	1	16900	10,9
80-90	4	9224	5,9
TOTAL		**155646**	**100,0**

Zones and distances.

The distance is one of the categories that provides the accessibility level of population.the distance determines the remoteness of entities (localities) from facilities (Comrat town) and vice versa. There were defined buffer zones of 10 km with the purpose to group the localities by distance to the administrative centre of ATUG (fig.2, Table 3). The territory of autonomous unit was „covered" by nine meridional buffer zones.

The most numerous, as inhabitants, are zones I, III and IV, concentrating over 63% of ATUG population in 16 localities. In zone I live 21,8% of population of

autonomous unit. This zone concentrate the population of 5 localities, including Comrat town. Zone VII doesn't contain any localities.

On the greatest distance on straight lines of *Comrat* town are situated the localities *Etulia Nouă* (88,32 km), *Etulia* (86,0 km), *Cişmichioi* (86,0 km). The nearest localities to Comrat town are *Chirsova* (6,4 km), *Congazcicul de Jos* (6,8 km), *Bugeac* (7,5 km).

Accessibility and routes.

The term of „accessibility" is often confused with „mobility", i.e. the ability to go from one place to another. The word "accessibility" is derived from the words access and ability to access. Access is approached as the possibility to become closer to something (Hansen, 1959). Access is moving across the network in order to arrive at the destination.
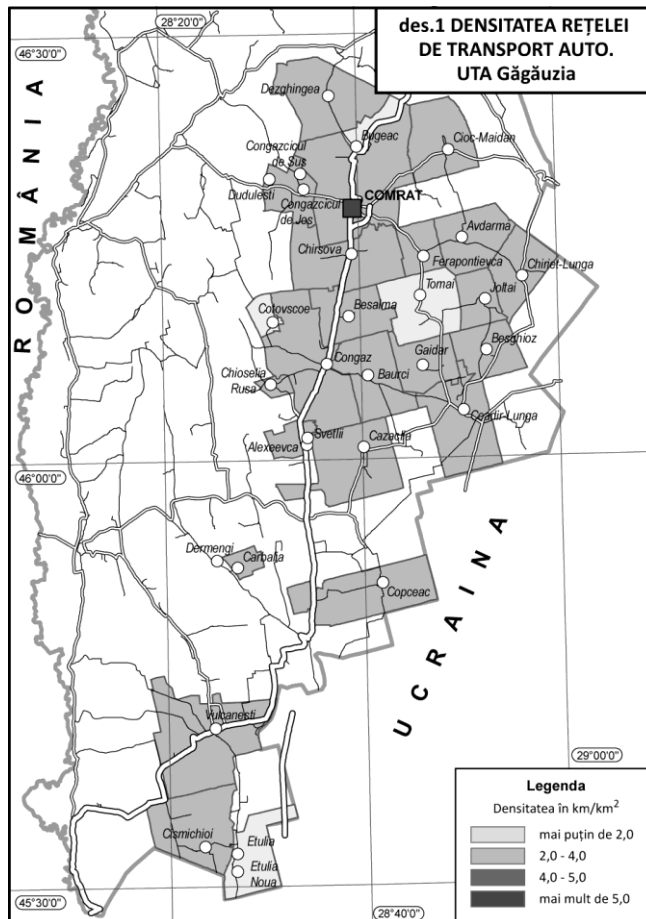
High level of mobility not always means a high level of accessibility. A high level of accessibility can be achieved in case of a low mobility (Miller, 1999). The level of accessibility can be influenced by several factors: arrivals in urban zones, wich are slower than crossing; road quality; transport network quality and afficiency; the presence of natural barriers etc.

Starting with the above mentioned there were set up 32 access routes to *Comrat* town (fig.3, Table 2). The drawn routes are largely served by the autonomous unit's personal transport network. Exceptions are only several localities which use roads from afferent transport networks (Cahul and Taraclia district): *Etulia, Cismichioi, Carbalia, Chioselia, Vulcănesti town, and Copceac.*

The performed measurements have distinguished several groups of localities, that fall in different time access zones. The large majority of localities (24) are sittuated at a distance of one hour from Comrat town, the remaining are at 1-2 hours distance (Table 4, fig.4).

Tab 4. Distribution of population by zones of 30 minutes (isochrones)			
Zones (minutes)	Frequency	Population (hab.)	Population (%)
0-30	14	71996	46,3
30-60	10	48838	31,4
60-90	4	10388	6,7
90-120	5	24424	15,7
TOTAL		155646	100,0

Length of route. Accessibility is also determined by the legth of routes, that indicate the distance from the start till the destination. Routes being the covered ways to the destinations within the network. The smallest route length indicators are recorded for localities *Chirsova* (6 498 m), *Congazciucul de Jos* (7 290 m) and *Bugeac* (9 061 m), which are located in the immediate vicinity of Comrat town. High length indicators are recorded in coomunes *Etulia Nouă* (95 180 m), *Cismichioi* (94 199 m), *Etulia* (92 540 m).

An interesting situation is registered in case of several localities that record different time and length indicators, being sittuated at larger distances, register
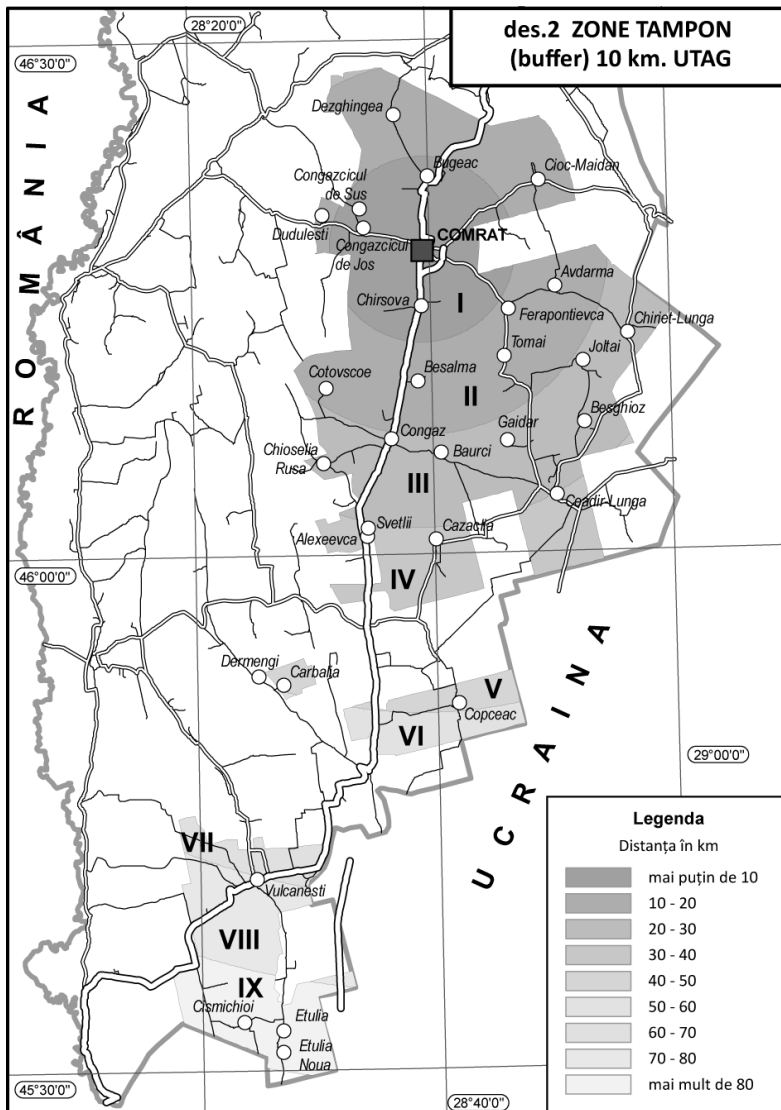
shorter time access, than other localities, that are sittuated closer to the destination. This difference is due to different speed, recorded on different road categories.

The speed inflences the time spent by people till the destination where facilities are offered. In our case the speed is directly connected to the road category. In the network the average speed of crossing the road segments is 43,4 km/h (Table 2).

Table 5. Distance Matrix – ATU Gagauzia																																Vulcanesti
	Alexeevca	Avdarma	Baurci	Besalma	Besghioz	Bugeac	Carbalia	Cazaclia	Ceadir-Lunga	Chioselia Rusa	Chiriet-Lunga	Chirsova	Cioc-Maidan	Cismichioi	Comrat	Congaz	Congazcicul de Jos	Congazcicul de Sus	Copceac	Cotovscoe	Dermengi	Dezghingea	Dudulesti	Etulia	Etulia Noua	Ferapontievca	Gaidar	Joltai	s.c.f. Etulia	Svetlii	Tomai		
Alexeevca	0	42	17	19	39	40	26	16	30	10	51	26	47	63	32	11	39	41	27	21	32	48	40	61	64	35	27	41	61	1	31		48
Avdarma	42	0	33	23	19	25	68	42	28	40	10	20	13	104	17	31	25	27	60	42	73	33	30	102	105	7	23	11	102	42	12		89
Baurci	17	33	0	10	23	35	42	10	14	15	34	20	41	77	26	6	33	36	30	17	48	42	35	75	78	26	10	26	75	17	21		62
Besalma	19	23	10	0	30	24	45	20	24	17	33	10	31	81	16	8	23	25	40	19	51	32	29	79	82	16	19	22	79	20	11		67
Besghioz	39	19	23	30	0	43	59	26	10	37	12	38	32	89	35	29	43	45	41	39	65	51	49	88	90	23	18	8	87	40	19		75
Bugeac	40	25	35	24	43	0	66	45	44	38	35	15	23	102	8	29	15	17	65	40	72	8	20	101	103	21	37	36	100	41	26		88
Carbalia	26	68	42	45	59	66	0	34	50	32	71	51	73	44	58	36	65	67	27	43	6	74	65	44	47	61	52	67	44	25	56		27
Cazaclia	16	42	10	20	26	45	34	0	16	23	37	30	51	66	36	16	43	46	20	27	40	52	45	65	67	35	20	33	65	15	30		52
Ceadir-Lunga	30	28	14	24	10	44	50	16	0	28	21	34	42	79	36	19	43	45	31	30	56	52	49	78	80	23	9	18	77	31	18		65
Chioselia Rusa	10	40	15	17	37	38	32	23	28	0	49	24	45	72	30	9	37	39	37	12	38	46	36	71	73	33	24	39	70	11	28		57
Chiriet-Lunga	51	10	34	33	12	35	71	37	21	49	0	30	23	101	27	40	34	37	53	51	77	43	40	99	102	16	29	18	99	51	22		86
Chirsova	26	20	20	10	38	15	51	30	34	24	30	0	21	88	6	15	14	16	50	26	57	22	19	86	89	15	28	31	86	26	21		73
Cioc-Maidan	47	13	41	31	32	23	73	51	42	45	23	21	0	109	15	36	23	25	71	47	79	31	28	107	110	20	36	24	107	48	25		95
Cismichioi	63	104	77	81	89	102	44	66	79	72	101	88	109	0	94	73	101	104	52	83	45	110	102	7	9	97	86	97	4	62	93		17
Comrat	32	17	26	16	35	8	58	36	36	30	27	6	15	94	0	21	7	10	57	32	64	16	13	93	95	13	29	28	92	33	18		80
Congaz	11	31	6	8	29	29	36	16	19	9	40	15	36	73	21	0	28	31	36	11	42	37	30	71	74	24	16	31	71	11	20		58
Congazcicul de Jos	39	25	33	23	43	15	65	43	43	37	34	14	23	101	7	28	0	3	64	36	71	17	7	100	102	20	36	35	99	40	25		87
Congazcicul de Sus	41	27	36	25	45	17	67	46	45	39	37	16	25	104	10	31	3	0	66	37	73	14	6	102	104	22	38	37	102	42	27		89
Copceac	27	60	30	40	41	65	27	20	31	37	53	50	71	52	57	36	64	66	0	46	33	72	65	50	53	55	40	49	50	26	49		37
Cotovscoe	21	42	17	19	39	40	43	27	30	12	51	26	47	83	32	11	36	37	46	0	49	48	34	82	84	35	27	41	81	22	30		67
Dermengi	32	73	48	51	65	72	6	40	56	38	77	57	79	45	64	42	71	73	33	49	0	80	69	45	48	67	58	73	45	31	62		27
Dezghingea	48	33	42	32	51	8	74	52	52	46	43	22	31	110	16	37	17	14	72	48	80	0	17	108	111	28	44	43	108	49	34		96
Dudulesti	40	30	35	29	49	20	65	45	49	36	40	19	28	102	13	30	7	6	65	34	69	17	0	100	103	26	42	41	100	41	31		87
Etulia	61	102	75	79	88	101	44	65	78	71	99	86	107	7	93	71	100	102	50	82	45	108	100	0	3	96	84	95	3	60	91		18
Etulia Noua	64	105	78	82	90	103	47	67	80	73	102	89	110	9	95	74	102	104	53	84	48	111	103	3	0	98	87	98	6	63	94		21
Ferapontievca	35	7	26	16	23	21	61	35	23	33	16	15	20	97	13	24	20	22	55	35	67	28	26	96	98	0	16	16	95	36	5		83
Gaidar	27	23	10	19	18	37	52	20	9	24	29	28	36	86	29	16	36	38	40	27	58	44	42	84	87	16	0	16	84	27	11		71

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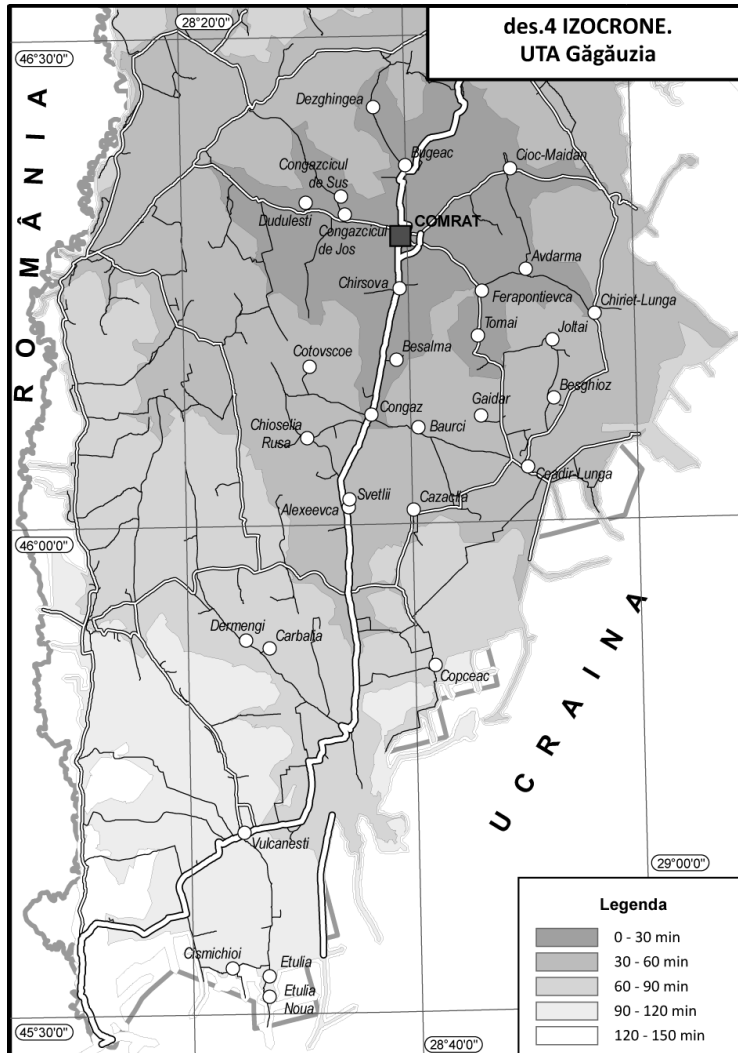|																															
Joltai	41	11	26	22	8	36	67	33	18	39	18	31	24	97	28	31	35	37	49	41	73	43	41	95	98	16	16	**0**	95	42	11
s.c.f. Etulia	61	102	75	79	87	100	44	65	77	70	99	86	107	4	92	71	99	102	50	81	45	108	100	3	6	95	84	95	**0**	60	91
Svetlii	1	42	17	20	40	41	25	15	31	11	51	26	48	62	33	11	40	42	26	22	31	49	41	60	63	36	27	42	60	**0**	31
Tomai	31	12	21	11	19	26	56	30	18	28	22	21	25	93	18	20	25	27	49	30	62	34	31	91	94	5	11	11	91	31	**0**
Vulcanesti	48	89	62	67	75	88	27	52	65	57	86	73	95	17	80	58	87	89	37	67	27	96	87	18	21	83	71	82	18	47	78
Vulcanesti c.f.m.	44	85	58	62	71	84	27	48	61	54	82	69	90	20	76	54	83	85	33	65	31	91	83	19	21	79	67	78	18	43	74

The average speed of crossing different road categories was determined through GPS measurements of road portions. This indicator is average one. Obviously it is a general indicator, however it can be easily modified for its application in calculations for entire road network.

des.2 ZONE TAMPON (buffer) 10 km. UTAG

Legenda
Distanța în km

- mai puțin de 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- mai mult de 80

The highest speed (65 km/h) is recorded on *„Improved asphalted roads"* and *„Asphalted roads", i.e. categories 1 and 2*. It's important to note that on these roads even higher speeds can be achieved, but it was taken average speed
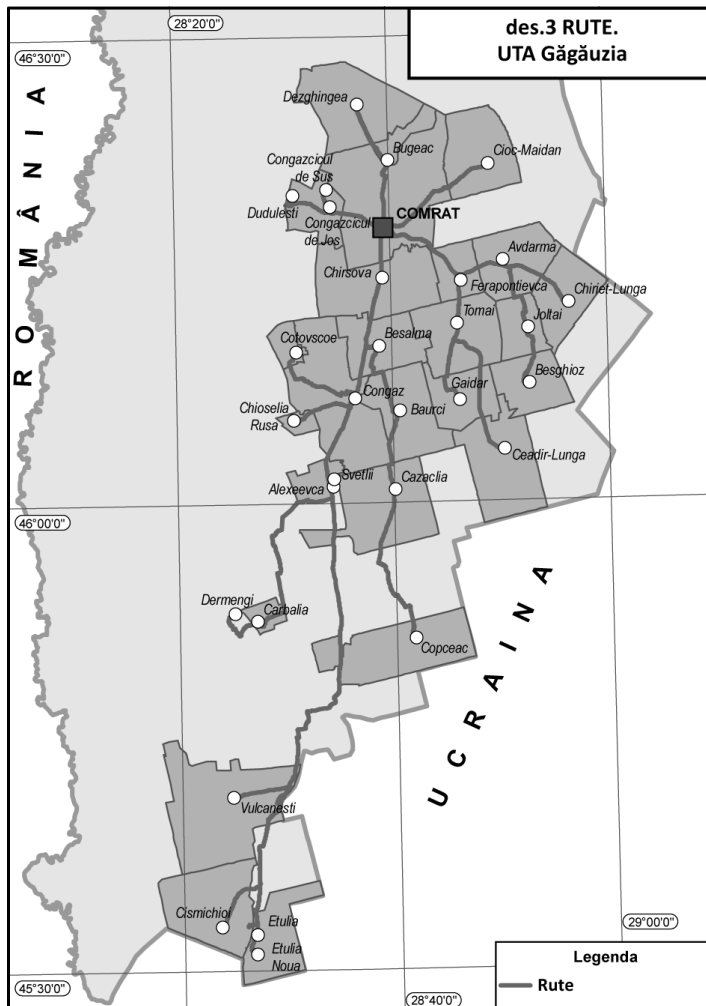
The lowest speed in network was recorded on the road category named „*Paths and country roads*" – 15 km/h. It was also recorded the average speed of

des.4 IZOCRONE.
UTA Găgăuzia

Legenda

0 - 30 min
30 - 60 min
60 - 90 min
90 - 120 min
120 - 150 min

crossing the localities. The roads in localities were divided into two categories – „*Central roads in localities*" and „*Secondary roads in localities*", 30 and 18-15 km/h respectively. This road category greatly influences the accessibility, because the fewer arrivals there are in localities, the shorter is the time spent till the destination.

As the example it can be taken the case with *Gaidar* and *Chiret-Lunga* localities, that are situated at the same distance from Comrat town, but access time and average speed are different. It is because of the number of localities existing on the way of the route *Chiret-Lunga – Comrat* (8 localities), that reduce the speed from 65 to 30 km/h. In addition the route *Chiret-Lunga – Comrat* is formed road of lower speed categories, while the route *Gaidar – Comrat* represents segments of road with higher average speed (60 km/h).

The study also points out the routes that register the highest crossing speed. For example, route of 14,2 km *Cioc-Maidan – Comrat* is covered with an average speed 60 km/h, *Avdarma – Comrat* (14,6 km) speed 55 km/h, *Cismichioi - Comrat* (23,8 km) with a speed of 55 km/h. Concerning the localities Cioc-Maidan and Avdarma, the high speed is explained by the connection of these localities with Comrat though the roads of categories 1 and 2 with high speeds. The lowest indicators are recorded on the routes *Baurci – Comrat* (27 km/h), *Cazaclia – Comrat* (27 km/h) etc. On the short routes is recorded low average speed and inversely on long distances average speed is high

Routes' sinuosity. An indicator frequently used in road network analysis is road sinuosity, which was taken from hydrology for calculating river's sinuosity. It was tried to adapt this indicator with reference to routes' sinuosity. Such tests are already done by calculating the Detour index (Rodrigue et all, 2009). This index shows the assertion „geographical proximity is not always a high accessibility".

In its calculation was used the ratio of indicators of straight lines distance and route length (Table 2). The highest indicators are recordeed in case of following localities: *Chirsova* (0,99), *Congaz* (0,99), *Sveltlii* (0,97), *Alexeevca* (0,96), and *Congazcicul de Jos* (0,93). The lowest indicator is recorded in *Cotovscoe* (0,58) where the route is 2 times longer than straight line distance from *Comrat* town. It is followed by *Berghioz* (0,72), *Joltai* (0,76), and *Dermengi* (0,63).

The sinuosity coefficient is influenced by several factors, as follows: natural barriers (relief, hydrography, vegetation etc), localities and, in our case, lack of direct roads of necessary category (1, 2, 4, 5 and 6). Unlike Cahul district where the sinuosity indices are lower, in ATUG the values are higher, that says about a relatively insignificant impact of natural barriers on the road network.

The Degree of Circuity in network. It is an indicator that measures the traffic level for every locality from transport network. Obviously it is one of the range of indicators (cyclomatic index, alpha, beta, gamma, eta, pi, iota, total transport score etc.) that caracterise a network (Kansky, 1989; Rodrigue et all, 2009). There was selected an indicator that caracterises the *Degree of Circuity in network,* because in the above listed indicators is considered the number of nodes and arcs in network, equaling all network elements as value and importance, also the valence, and its costs.

Table 6 Degree of Circuity for road network of ATUG					
Locality	Km per locality	Km per locality in network	Locality	Km per locality	Km per locality in network
Alexeevca	205,15	6,22	Congazcicul de Sus	278,80	8,45
Avdarma	286,15	8,67	Copceac	280,85	8,51
Baurci	221,23	6,70	Cotovscoe	362,12	10,97
Besalma	183,84	5,57	Dermengi	474,38	14,38
Besghioz	334,12	10,12	Dezghingea	232,07	7,03
Bugeac	210,56	6,38	Dudulesti	274,76	8,33
Carbalia	338,22	10,25	Etulia	296,28	8,98
Cazaclia	243,62	7,38	Etulia Noua	309,86	9,39
Ceadir-Lunga	226,16	6,85	Ferapontievca	245,03	7,43
Chioselia Rusa	229,73	6,96	Gaidar	294,94	8,94
Chiriet-Lunga	323,43	9,80	Joltai	321,94	9,76
Chirsova	192,81	5,84	Etulia s.c.f.	315,43	9,56
Cioc-Maidan	258,44	7,83	Svetlii	195,44	5,92
Cismichioi	335,23	10,16	Tomai	256,38	7,77
Comrat	146,92	4,45	Vulcanesti	332,24	10,07
Congaz	150,14	4,55	Vulcanesti c.f.m.	274,35	8,31
Congazcicul de Jos	265,18	8,04			
AVERAGE IN NETWORK - 8,16 km					

In our case, the localities of ATUG can serve as network nodes, but segments are the roads of major importance for the traffic (main, republican, and local roads) that link these localities. As for the first step a distance matrix was constructed for localities of ATUG. (Table 5, 6).

Degree of Circuity in a network is calculated using the following formula:

$$GC = \frac{\sum_{i=1}^{n}(E-D)^2}{v},$$

Where $\sum_{i=1}^{n}$ is number of routes, E – route length, D – euclidian distance (straight lines), v - number of nodes (ATUG localities).

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This index shows the pressure on every node (locality) within a network. It is assumed that nodes are of the same level of value. The lowest indicators are recorded in the following localities: Comrat, Congaz, Besalma and Chirsova. High indicators are registered in Dermenji, Cotovscoe and Carbalia

Conclusions

1. The road network in ATUG doesn't assure the access of population to the administrative centre. There are used afferent networks, especially the roads of Cahul and Taraclia districts.

2. In case of ATUG, time accessibility difers from length accessibility.

3. The higher is the weight of roads of greater categories, the higher is the level of accessibility and the average crossing speed.

4. The localities set on the route's way increase the time of access.

5. The existence of the three administrative centers, of a lower rank, within ATUG (Comrat, Ciadar-Lunga and Vulcanesti), somehow disperses the road density indicators and approach the services to the population.

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