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Seria GEOGRAFIE

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THE ENVIRONMENTAL ASSET OF THE RURAL FROM ORADEA METROPOLITAN AREA (ROMANIA)

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Abstract: Starting from one of the main objectives of constitution of Oradea Metropolitan Area (O.M.A.) namely to ensure the continuous increase of live quality, the aim of the study is the highlight and analysis of high value natural resources, natural reserves and Natura 2000 sites and also to ensure the quality of environmental factors for the touristic use. The importance of protection and conservation of some natural elements also results from the fact that the surface of natural reserves within O.M.A. increases from 6.25% of overall surface of natural reserves of Bihor county, prior the integration in the E.U., to 24.3% after the European

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integration, after the implementation of Natura 2000 ecological network. One can identify nine Natura 2000 sites within O.M.A., which includes two SPA and seven SCI sites. The analysis of the environmental factors (air, surface and underground waters) shows that the physical and chemical parameters are within the legal range without threatening the communities and the natural resources with touristic potential.

Key words: Oradea Metropolitan Area, natural protected areas, Natura 2000, quality of environmental elements, biodiversity, environmental touristic potential

* * * * * *

INTRODUCTION

In its simplest meaning, the biodiversity is "the sum of all living creatures from the Earth, linked by abiotic components of the planet such as: atmosphere, oceans, fresh waters, geology, soils". All forms the "biosphere" (biologyreference.com, Friedman, 2010). Secondary, the biodiversity of an area also supply a set of ecological services, represented by fresh water, protection of local communities by natural disasters, food and raw materials supply a.s.o. In the broadest sense, we can also add that the biodiversity *favourise the progress of touristic activity*.

Restraining the ideas to local scale, the analysis will focuses on Oradea Metropolitan Area (O.M.A.). The general objective of the 12 administrative components (Oradea municipium and Biharia, Cetariu, Paleu, Ineu, Oşorhei, Sînmartin, Nojorid, Sîntandrei, Toboliu, Girişu de Criş and Borş communes) is represented by increasing the living standards by using the existing resources and promoting the natural potential. We consider that two of the main resources of O.M.A. are given by the protected areas (natural reserves and Natura 2000 sites) and the good quality of environmental factors.

The aim of the study is to highlight these two resources in two ways:

- the real possibility that these two resources to get into attention of local administration by a qualitative and quantitative integration of the information into management plans but also for future investors who are interested in a sustainable use of the local environment;

- the care for increasing the living standards of the inhabitants of O.M.A. through possible popularization activities but also through the increase of consciousness of the individuals and communities who take care of the environment.

The question of relevance of living environment compared to the ecosystem balance of the protected areas, the human impact, the increase of local inhabitants awareness are found in some studies (Ilieș et al., 2017a; Ilieș et al., 2017b; Wendt et al., 2019). An other study (Tătar et al., 2018) deals with the opportunities offered by natural environment for touristic activities but the protected areas were just tangentially analysed.

MATERIALS AND METHODS

The methodological analysis was oriented towards two main directions: collecting and analysis of quantitative and qualitative information from references and the field survey. The analysis of references comes from references which deals the topic related to analysis of O.M.A. and Bihor county but also online sources. The field survey focused on: the geomorphological, biogeographical, hydrological, landscape analysis; the analysis of environmental factors and components focusing on the analysis of dynamic evolution for each commune; analysis of detailed survey images acquired by Phantom 4 DJI drone images in order to observe the effects of human intervention upon protected areas.

The quantitative and qualitative data and the field surveys were previously analysed in detail. [1] Within the quantitative analysis, for "Point A. *Natural touristic resources*", for the criteria

[1] https://lege5.ro/../metodologia-pentru-analiza-potentialului-turistic-al-teritoriului-din-..

"***Natural protected areas***" (total number of 5 points) was taken into consideration the following aspects for each commune within O.M.A.: degree of representativity of the protected area (max. 1 point), the total surfacsitee of protected area (as percentage from the administrative territory, max. 1 point), degree of conservation and the present state of the reserve (max. 1 point), the landscape value of the protected area (max. 1 point), the possibility of practicing different form of tourism (max. 1 point).

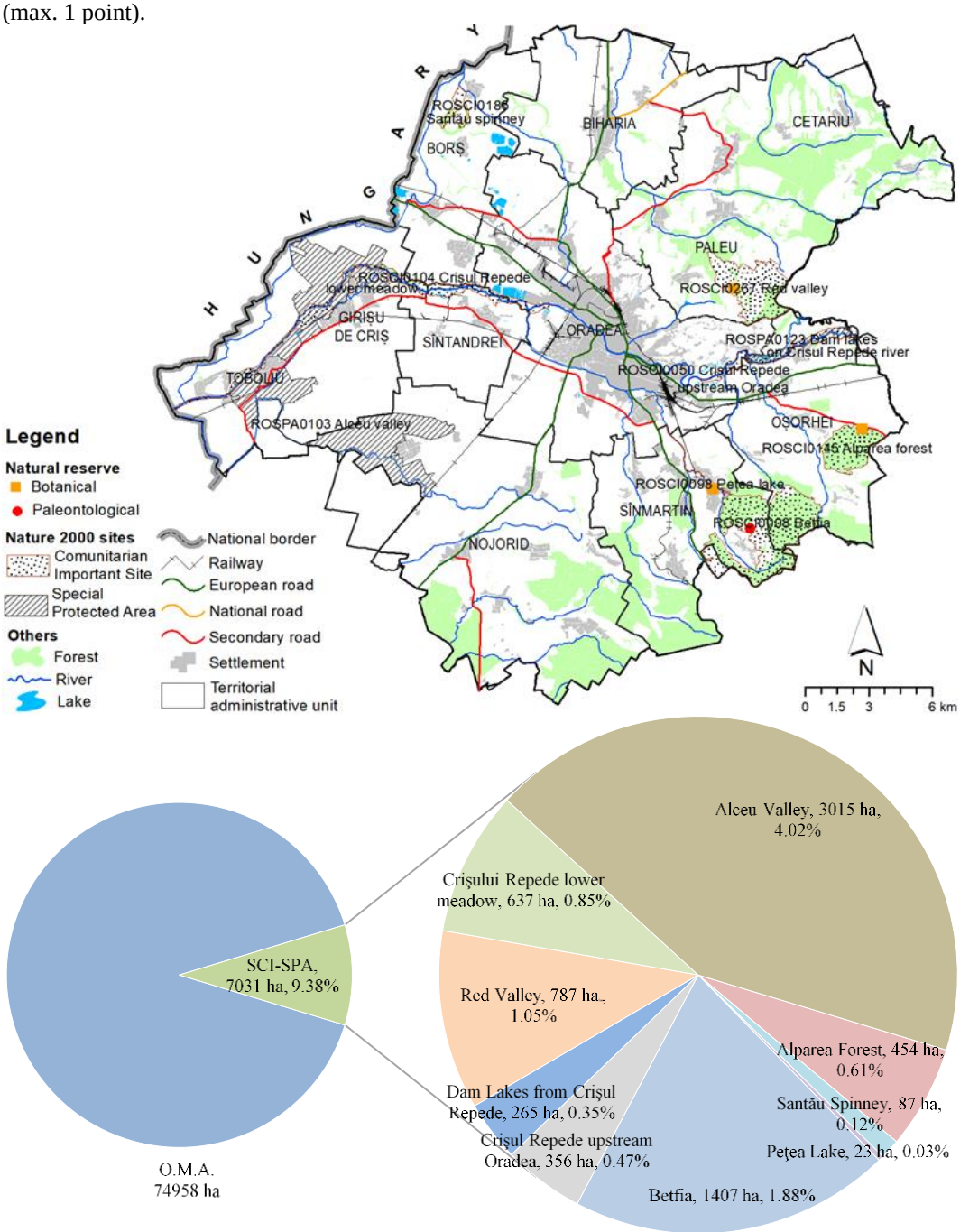

Figure 1. Protected areas of Oradea Metropolitan Area (O.M.A)

RESULTS

Natural Protected Areas

Uniqueness, scientific importance, danger of extinction, representativity, utility were sets of priorities for protection and conservation of some elements of the natural environment. Thus, within the territory of O.M.A., prior the E.U. adherence, were four *natural reserves* (6.25% of overall protected area surface of Bihor county)[2]: Peţa brook Botanical Reserve (4 ha), Şomleu Hill Paleontological Reserve (5 ha), both located within Sînmartin commune administrative territory, Daffodils Forest from Alparea Botanical Reserve (Oşorhei commune, 2 ha), Meadows from Red Valley Botanical reserve (4 ha, Săldăbagiu de Munte village, Paleu commune).

After the integration in the E.U., the Natura 2000 ecological network was created, with two major components, S.C.I. (Sites of Community Importance) and S.P.A. (Special Protected Areas). Within O.M.A., nine Natura 2000 sites were created (24.3% of overall protected area of Bihor county), two S.P.A. sites and seven S.C.I. sites (figure 1), with a total area of 7,031 ha (9.38% of O.M.A. total area). Seven Natura 2000 sites already have Management Plans and for two sites (*ROSCI0185 Santău Spinney and ROSCI0267 Red Valley*) just standard information sheet is available.

Table 1. The score of each Natura 2000 site
according to Methodology of evaluation of touristic potential in territorial and administrative units, Annex A

Natura 2000 site	Degree of representativity (max 1 point)	Total surface of protected area (max 1 point)	Degree of conservation and the present state of the reserve (max 1 point)	Landscape value (max. 1 point)	Possibility of practicing different forms of tourism (max. 1 point)	Total score of protected area (max 5 points)	Average score
ROSCI0145 Alparea Forest	1	0.8	1	1	1	**4.8**	**4,4**
ROSCI0185 Santău Spinney	0.7	0.8	0.7	0.8	0.7	**3.7**	
ROSCI0098 Peţea Lake	1	0.8	0.3	0.6	0.8	**3.5**	
ROSCI0008 Betfia	1	0.8	1	1	1	**4.8**	
ROSCI0050 Crişul Repede upstream Oradea	1	0.7	1	1	1	**4.7**	
ROSPA0123 Dam Lakes from Crişul Repede	0.9	0.7	1	1	1	**4.6**	
ROSCI0267 Red Valley	1	1	1	1	1	**5**	
ROSCI0104 Crişului Repede lower meadow	1	1	0.7	0,8	0,9	**4.4**	
ROSPA0103 Alceu Valley	1	0.9	1	0,8	0,8	**4.5**	
Mean score of the criterion	**0.96**	**0.83**	**0.86**	**0.89**	**0.91**		
Mean score for O.M.A.	**0.89**						

[2] In Bihor county are officially designated 64 natural reserves of national interest, 13 of local interest, 37 Natura 2000 sites (9 S.P.A., 28 S.C.I. sites) and two natural parks (Cefa Natural Park, 5,002 ha, located in the vicinity of O.M.A. and Apuseni Natural Park, which covers three counties, 64,000 ha)

Alparea Forest Natura 2000 ROSCI0145 site

For *degree of representativity* subcriterion the site is granted with the maximum value, 1 point, because the site includes in the northern part the *Daffodils Forest from Alparea Botanical Reserve* (I.U.C.N. III category), proposed for conservation since 1984 by Marrosy Anna, currently being a protected area of national importance (Tuduce et. al., 2001).Here, one can find *Narcissus poeticus ssp. Radiiflorus*, located at one of the lowest altitudes in Romania and also being at the edge of ecological optimum.

For *overall protected surface* subcriterion (as part of overall administrative surface) the site is granted with 0.8. The protected area covers 459 ha, located over the administrative territory of two communes, just Oșorhei commune being part of O.M.A. (the protected area covers 7% from Oșorhei commune administrative territory, the rest being located in Copăcel commune, with less than 1%).

For *degree of conservation* and *current state of the reserve* subcriterion the site is granted with 1 point. The daffodils appear in bunches or as isolated individuals (figure 2), the flowers cover areas more than few square meters just isolated. The ROSCI0145 Natura 2000 site was proposed for protection in order to preserve the forest habitats (oak mixed with sessile and hornbeam) and to protect three species of amphibians - *Bombina bombina*; *Bombina variegata, Triturus cristatus,* all three species being in a good conservation status. [3]

Figure 2. Alparea Forest Natura 2000 ROSCI0145 site
Left down, bunches of *Narcissus poeticus ssp. Radiiflorus* blossoming in May

For the *landscape value of protected area* subcriterion the site is granted with 1 point because the areas in a natural state are well preserved (compact forests, meadows, brooks, wild fauna, visible image elements, large volumes of green areas, structures generated by compact forest areas, viewing and opening axes sometimes limited but very suggestive).

[3] http://www.mmediu.ro/app/webroot/uploads/files/2015-09-21_ROSCI0145_Padurea_Alparea_Plan_management.pdf

For the *possibility of practicing different form of tourism* subcriterion the site is granted with the maximum score, 1 point, because there are multiple possibilities for discovery and scientific forms of tourism which are supported by road network and meadows, allowing accessibility.

Thus, the Alparea Forest Natura 2000 ROSCI0145 site is granted with 4.8 points (table 1, figure 10).

Santău Spinney Natura 2000 ROSCI0185 site

For *degree of representativity* subcriterion the site is granted with 0.7 points because the site doesn't have any natural reserve within its territory.

For t*otal surface of protected area* subcriterion the site is granted with 0.8 points. The site in entirely within O.M.A., respectively, Borș commune, but occupies a small area (113 ha, respectively 2% of the commune's territory).

For *degree of conservation and present state of the reserve* subcriterion the site is granted with 0.7 points. The site has just "Standard Form" in which are presented just basic information about the site, namely that is an alluvial forest with *Alnus glutinosa* and *Fraxinus excelsior,* peat bogs, swamps, arable land, meadows and pastures (figure 3). which protects habitats with *Salix alba, Populus alba, Alnus glutinosa, Fraxinus excelsior* and also endangered/rare fauna elements such as fishes (*Umbra krameri*), amphibians, *Bombina bombina,* considered to be an vulnerable species, on the Red List of the I.U.C.N.[4] In the "Standard Form" are also mentioned the vulnerability for illegal logging, draining's, agriculture, clogging.

Figure 3. Santău Spinney Natura 2000 ROSCI0185 site

For *landscape value* subcriterion the site is granted with 0.8 point. One can find here a mosaic type landscape association between the green, natural part of the corridor and the agricultural land. For *possibility of practicing different forms of tourism* subcriterion the site is granted with 0.7 points. This value is supported by a limited number of persons involved in discovery and weekend forms of tourism. Thus, Santău Spinney Natura 2000 ROSCI0185 site totals a number of 3.7 points (table 1, figure 10).

Peța Lake Natura 2000 ROSCI0098 site

For *degree of representativity* subcriterion the site is granted with 1 point because it includes a famous for its endemisms nature reserve, namely *Peța lake Botanical Reserve* (4 ha, within Sînmartin commune territory) which is famous for its three endemisms living in a subtropical type ecosystem, considered to be relicts from the last Ice Age: the thermal water lily (*Nymphaea lotus var. Thermalis*), thermal snail (*Melanopsis parreyssi 'Moellendorff' Philippi* -

[4] http://biodiversitate.mmediu.ro/rio/Natura2000/static/pdf/rosci0185.pdf

1847) (recently re-evaluated as *Microcolpia parreyssii)*,[5] thermal rudd (*Scardinius racovitzai Müller* - 1958), but also other species of community interest.

For *total surface of protected area* subcriterion the site is granted with 0.8 points. The site is entirely located within O.M.A. but it covers just a small area (49 ha, just 0.1% of the Oradea surface and 0.4% from Sînmartin commune surface).

For *degree of conservation and present state of the reserve/Natura 2000 site*, the site is granted with 0.3 points. The small score can be explained by the fact that the site is in an ecological collapse. From 2011, the Peta Lake ecosystem is in a real ecological crisis for two reasons: the drastic reduction of the water level from the lake which led in 2012 and 2015 to a complete drying up and to a significant decrease of water temperature at about 11°C (far under the physiological needs of thermal species).

In situ, the thermal snail and the thermal rudd were declared extinct by the former custodian of the reserve.[6] The rhizome and the seeds of the thermal water lily proved to be extremely resilient because in the summer of 2013 even in the summer of 2015 the flowers blossomed. Currently the plant survives in artificial pool condition in Băile Felix Spa but rarely individuals blossomed in Peta brook, outside the natural reserve but inside the area of the Natura 2000 site (figure 4). This species is a rare/endangered taxon which is not evaluated by I.U.C.N. The field survey made in 2015 for the Management Plan were identified a population of 77 individuals (33 individuals in the lake, the rest along the brook)[7] (Orășeanu and Malancu, 2017; Orășeanu et al., 2017; Grigoraş et. al., 2015; Ilieş et. al., 2015; Linc and Staşac, 2015; Şoldea, 2003; Marossy, 1999; Oltean-Cosma, 1991; Borza, 1924. Also, worth mention that the water lily is nature monument and on the bank of the lake one can find an oak tree of about 300 years old.

Peţa brook botanical reserve

Water lily *Nymphaea lotus var. Thermalis.* The only in situ surviving species

Figure 4. Peţa Lake Natura 2000 ROSCI0098 site

Peţa Lake Natura 2000 ROSCI0098 site was declared protected area for *Priority Habitat 31A0* thermal waters from Transylvania covered by water lily* but the present conservation state is heavily affected. Within the perimeter of the Natura 2000 site one can also find other protected species of community interest such as *Unio crassus* (resident, isolated, native and very rare population) and *Chilostoma banaticum* (resident, native and rare population), *Rhodeus sericeus amarus* (sedentary/resident population, marginal, native, with definite presence), *Bombina variegata*, *Triturus cristatus*, *Bombina bombina*, *Emys orbicularis*.[8]

[5] http://www.mmediu.ro/app/webroot/uploads/files/2016-04-11_PM_ROSCI0098_Petea.pdf

[6] There is currently a malfunction in the management of a protected area after the publication of O.U.G. 75/2018 because from the law disappears the custodian term and it is established the National Agency for Natural Protected Areas (A.N.A.N.P.)

[7] http://www.mmediu.ro/app/webroot/uploads/files/2016-04-11_PM_ROSCI0098_Petea.pdf

[8] Idem

For the *landscape value* subcriterion the area is granted 0.6 points. Despite the fact that the rare species were not counted for the overall score, the landscape is attractive because of the huge size of the pine trees, because of the volumes of shrub associations with a marginal disposal around the lake and also because of the corridor effect of the Peța brook.

For the *possibility of practicing different form of tourism* subcriterion, the site granted 0.8 point, because of the vicinity of Băile Felix and Băile 1 Mai Spas which generates the visitor's flux and interest for discovery of the site.

Thus, the Peța Lake Natura 2000 ROSCI0098 site totals a number of 3.5 points (table 1, figure 10).

Betfia Natura 2000 ROSCI0008 site

Because the site includes *Şomleu Hill paleontological reserve,* well known for the fossils discovered here, the site granted 1 point. Șomleu Hill (figure 5) is well known in the international scientific literature because fossil site no. 2 represents a typical phase of the Lower Pleistocene, dated 1.4-1.6 mil years ago. From the 13 fossil sites were excavated 200 species of vertebrates, for ex. a species of bird *Palergosteon tothi*, amphibians *Pliobatrachus langhae*, *Parahynobius betfianus* and also a high variety of terrestrial microfauna.[9]

For the *total surface of protected area* subcriterion the site granted 0.8 point. The site covers 1,748 ha, located within three communes, two of them being situated within O.M.A. (Sînmartin: 14.2%, Oşorhei (8.2%), Hidişelu de Sus (3%).

Şomleu Hill paleontological reserve Betfia/Hudra Bradii Aven

Figure 5. Betfia Natura 2000 ROSCI0008 site

For *degree of conservation and present state of the reserve* subcriterion the site granted 1 point. The northern and eastern slopes of the hill are covered by ash, linden, wild cherry trees. Among the protected species one can find *Ruscus aculeatus*, with a population of about 500 individuals in a high degree of conservation although it is harvested because of its curative qualities and as ornamental plant. Inside Betfia Aven one can find bat colonies, *Myotis blythii, Myotis myotis şi Miniopterus schreibersii* species, with a population of about 11,000 individuals. Reptilian are also numerous, the most common species being *Elaphe longissima*, *Vipera berus*, *Lacerta viridis.* The bird species are represented by *Buteo buteo*, *Oenanthe oenanthe, Lanius minor, Lanius excubitor a.s.o.*[10]

The *landscape value of the site* subcriterion is granted 1 point. Because the area is a mixture of geomorphological features which belongs to endo (aven) and exokarst mixed with mature forest and shrub associations. For *possibility of practicing different forms of tourism*

[9] http://www.mmediu.ro/app/webroot/uploads/files/2016-04-11_PM_ROSCI0008_Betfia.pdf
[10] Idem

subcriterion the site granted 1 point. The spas located in the vicinity of the site supply a constant visitor's flux for different types of tourism. Thus, the Betfia Natura 2000 ROSCI0008 site totals 4.8 points (table 1, figure 10).

Crișul Repede upstream of Oradea Natura 2000 ROSCI0050 site

For *degree of representativity* subcriterion the site granted 1 point. It doesn't include any natural reserve; it is a Site of Community Importance (S.C.I.) but includes special protection site (Dam Lakes from Crișul Repede ROSPA0123 site).

For *total surface of protected area* subcriterion the site granted 0.7 point. It covers 2,006 ha but within O.M.A. is just Oșorhei commune (just 2.7% being under protection of the overall area), Ineu (1.5%), Oradea (0.9%), the rest being divided among the territory of other nine communes.

For *degree of conservation and present state of the reserve* subcriterion the site granted 1 point. Along Crișul Repede river, in both protected areas, one can find alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* which host a high variety of protected species such as *Unio crassus*, *Barbus meridionalis*, *Lutra lutra* which has stable populations.[11]

For *landscape value* subcriterion the site granted 1 point. The high score can be related by the value and diversity of the existing natural elements, the course of Crișul Repede river, Fughiu Lake (figure 6), the dam lakes, King's Land și Camelot recreational lakes, the forests and the elongated Oradiei Hills.

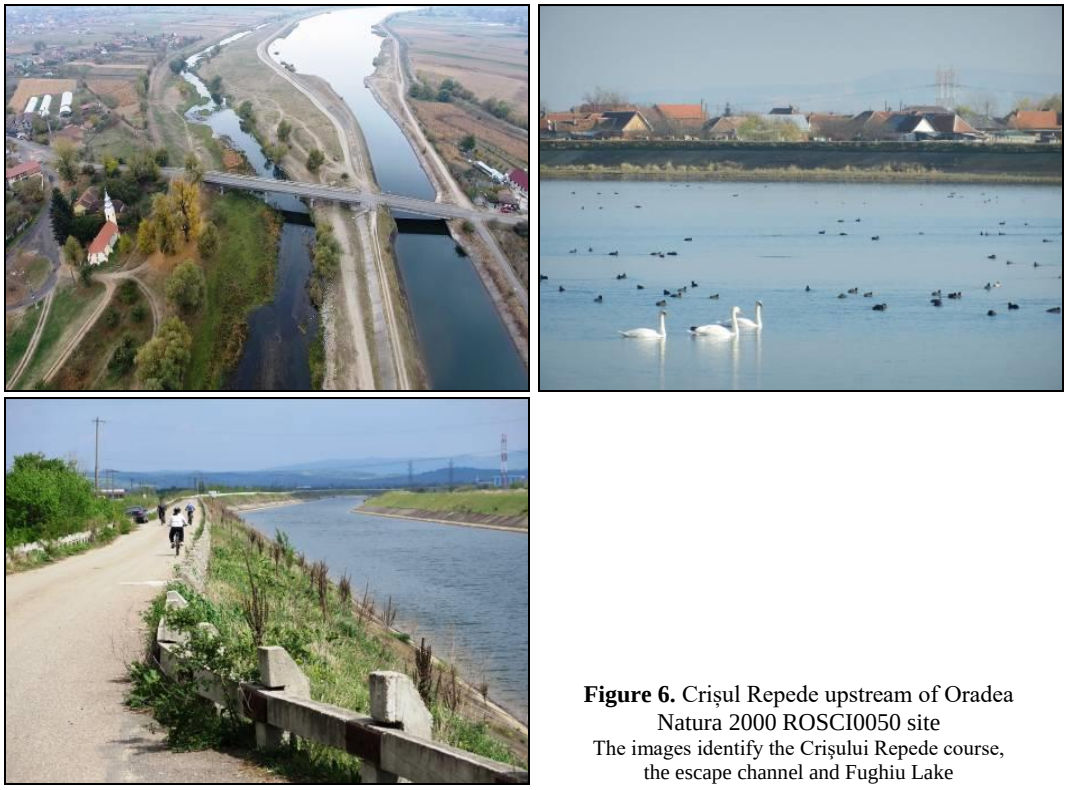

Figure 6. Crișul Repede upstream of Oradea Natura 2000 ROSCI0050 site
The images identify the Crișului Repede course, the escape channel and Fughiu Lake

Discovery tourism, horse ridding, sport fishing and adventure tourism (with light aircrafts) are *different forms of tourism* which granted the area 1 point.

Thus, the Crișul Repede upstream of Oradea Natura 2000 ROSCI0050 site totals 4.7 points (table 1, figure 10).

[11] http://www.mmediu.ro/app/webroot/uploads/files/2016-03-22_PM_REG_ROSCI0050_ROSPA0123.pdf

Dam Lakes from Crişul Repede Natura 2000 ROSPA0123 site

For *degree of representativity* subcriterion the site granted 0.9 point because it is included in a Site of Community Interest (Crişul Repede upstream of Oradea Natura 2000 ROSCI0050 site).

For *total surface of protected area* subcriterion the site granted 0.7 point. It covers 1,118 ha which overlap nine administrative units, just Oşorhei (2.7%), Ineu (1.5%) and Oradea (0.2%) being within O.M.A.

For *degree of conservation and present state of reserve/Natura 2000 site* subcriterion the site granted 1 point. The habitats are important for bird populations mentioned in Annex 1, 79/409/CEE such as *Nycticorax nycticorax, Egretta alba, Ciconia nigra, Ciconia ciconia, Lanius collurio, Aythya nyroca.* The site is also important for other species of birds unmentioned in Annex 1 such as *Ardea cinerea, Larus ridibundus, Gallinula chloropus, Vanellus vanellus*. The natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* are feeding and sheltering habitats for many fish and invertebrates species.[12]

For *landscape value* subcriterion the site granted 1 point because of the high degree of representativity of lakes and because of the high diversity of fresh water fauna, which are the main attraction elements.

For *possibility of practicing different forms of tourism* subcriterion the site granted 1 point because of the various tourist form opportunities - bird watching, sport angling, cycling.

Thus, Dam Lakes from Crişul Repede Natura 2000 ROSPA0123 site totals 4.6 points (table 1, figure 10).

Red Valley Natura 2000 ROSCI0267 site

For *degree of representativity* subcriterion the site granted 1 point because it overlaps the *Red Valley Grassland* botanical reserve (4 ha, east of Săldăbagiu de Munte village).

For *total surface of protected area* subcriterion the site granted 1 point because it covers upon the following administrative units: Paleu (15%) Oradea (0,1%), Oşorhei (0.1%), Ineu (1.4%), all members of O.M.A. This site protects an area of 819 ha.

Figure 7. Red Valley Natura 2000 ROSCI0267 site

For degree of conservation and present state of reserve/Natura 2000 site subcriterion the site granted 1 point although the score is granted reticently.[13] The site is covered by beech forests (Asperulo-Fagetum). Within the site one can find 14 plant species which are on the Red List together with amphibians and reptiles. The site is supposed to illegal logging. A part of the site overlaps Red Valley Grassland botanical reserve which is consisted of grasslands, deciduous forest

[12] http://www.mmediu.ro/app/webroot/uploads/files/2016-04-11_PM_ROSCI0098_Petea.pdf

[13] This Natura 2000 site doesn have a Management Plan. We noticed during the field survey that the information from the Standard Form are not confirmed on the field.

which host some protected species such as Salvia amplexicaulis, Rhinanthus borbasii (Corydalis solida ssp. slivenensis) a.s.o.[14, 15, 16] (Herman et. al., 2016; Ilieş et. al., 2017).

For *landscape value of natural protected area* subcriterion the site granted 1 point, because of the relevance of forest associations, grassland and shrub associations, the brook, as dominant attractiveness elements (figure 7) to which is added the elongated geometry of the hills and of the brook.

For *possibility of practicing different forms of tourism* subcriterion the site granted 1 point because of the high degree of accessibility and the richness of natural elements which can support different types of discovery, scientific, tourism, cyclo-tourism a.s.o.

Thus**,** Red Valley Natura 2000 ROSCI0267 site totals 5 points (table 1, figure 10).

Crişului Repede lower meadow Natura 2000 ROSCI0104 site

For *degree of representativity* subcriterion the site granted 1 point because partially overlap (42%) Valea Alceului ROSPA0103 site.

Figure 8. Crişului Repede lower meadow Natura 2000 ROSCI0104 site

For *total surface of protected area* subcriterion the site granted 1 point because the site covers 844 ha located entirely within O.M.A. (Borş: 0.2%, Girişu de Criş: 5.8%, Oradea: 0.5%, Sîntandrei: 6.1%, Toboliu: 3.2%).

For d*egree of conservation and the actual state of nature reserve/Natura 2000* site it granted 0.7 point because of the high degree of anthropization. The vegetation belongs to Pannonian biogeographical region, in the past the area being dominated by swamps and wetlands,

[14] http://biodiversitate.mmediu.ro/rio/Natura 2000/static/pdf/rosci0267.pdf
[15] https://www.econaturabihor.ro/wp-content/uploads/2013/02/Raport-expert-workshop2.pdf
[16] https://www.econaturabihor.ro/wp-content/uploads/2013/02/Raport-expert-workshop3.pdf

almost entirely drained by hydrotechnical works. The site is important for fish population and also for invertebrates. Characteristic are the hydrophilic habitats with *Salix alba* and *Populus alba.* Among protected species one can identify *Gobio albipinnatus*, *Zingel streber*, *Cobitis taenia*, *Rhodeus sericeus amarus.* The field survey identified other species such as *Emys orbicularis*, *Lutra lutra*, *Castor fiber.*[17]

For *landscape value of natural protected area* subcriterion the site granted 0.8 point on the basis of the high value of Crișului Repede, the meadow vegetation and because of a simple linear structure of components (figure 8).

For *possibility of practicing different forms of tourism* subcriterion the site granted 0.9 point. The most representative forms of tourism which can be practiced in the are being discovery and weekend tourism, sport angling.

Thus, the Crişului Repede Lower Meadow Natura 2000 ROSCI0104 site totals 4.4 points (table 1, figure 10).

Alceu Valley Natura 2000 ROSPA0103 site

For *degree of representativity* subcriterion the site granted 1 point because of the large territorial extension but also because the site overlap an other Natura 2000 (Crişului Repede Lower Meadow ROSCI0104 site).

For total surface of protected area subcriterion the site granted 0.9 point. The protected area covers 3,634 ha on the administrative territory of four communes (Girișu de Criș 25.9%, Nojorid 9%, Toboliu 16.5%), just Sînnicolau Român commune not being part of O.M.A.

For d*egree of conservation and the actual state of nature reserve/Natura 2000* site it granted 1 point. The area is well known for its wetlands and open habitats represented by agricultural lands, orchards, pastures, anthropic lake, the course of Crișul Repede river. The site offers habitats for 22 species from Annex 1 Birds Directive 79/409/CEE which find here conditions for sheltering, feeding, nesting, breeding such as *Falco vespertinus, Circus pygargus, Lanius minor, Lanius collurio, Circaetus gallicus, Aquila pomarina, Falco cherrug, Circus cyaneus, Himantopus himantopus, Tringa totanus, Platalea leucorodia, Nycticorax nycticorax.*[18]

For *landscape value* the site granted 0.8 points. The score is related to the relatively simple organisation of natural components, with few landscape plans and a very high agricultural influence (figure 9).

Figure 9. Alceu Valley Natura 2000 ROSPA0103 site

Thus, Alceu Valley Natura 2000 ROSPA0103 site totals 4.5 points (table 1, figure 10).

[17] http://www.mmediu.ro/app/webroot/uploads/files/2016-03-22_PM_REG_ROSCI0104.pdf
[18] https://www.mmediu.ro/app/../2016-06-09_PM_si_R_ROSPA0103_Valea_Alceului.pdf, https://milvus.ro/wp-content/uploads/2017/11/Plan_Management_ROSPA0103.pdf

Analysing figure 10 one can notice that just one protected area (ROSCI0267 Red Valley site) reach the maximum score (5 points), according to Methodology, and the lowest score is obtained by ROSCI0098 Peţea Lake (3.5 points). The average score of O.M.A. is 4.4 (table 1) which can be considered from environmental point of view as being attractive from touristic point of view.

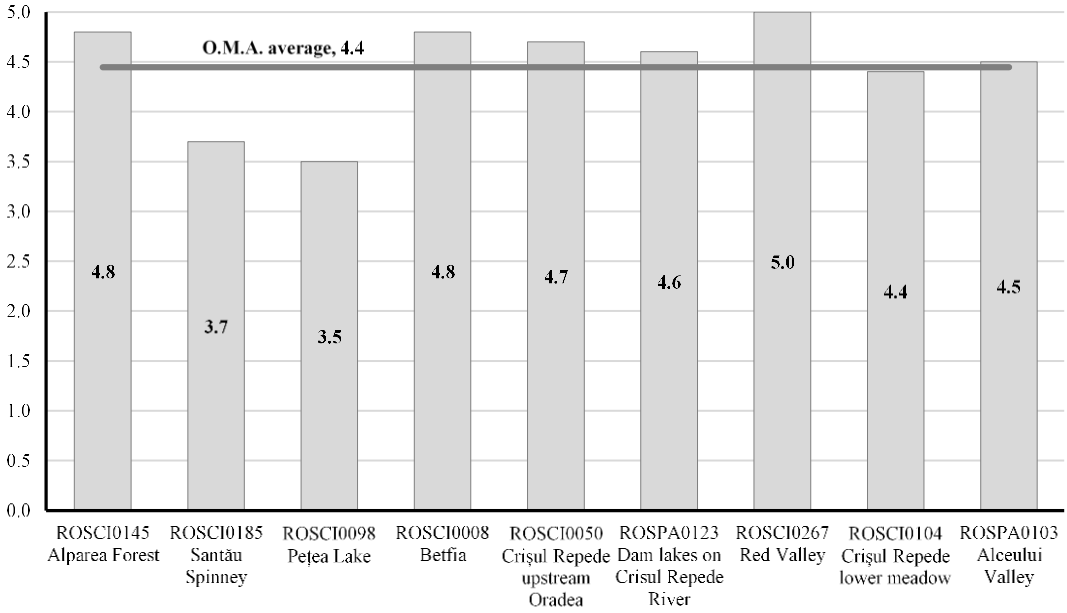

Figure 10. The score of Natura 2000 sites
according to Methodology of evaluation of touristic potential in territorial administrative units

At commune level, the protected areas from O.M.A. are consisted of 4 nature reserves, 9 Natura 2000 sites and two nature monuments, scoring between 1.8 and 3.5 points out of maximum 5 points (table 2). The lower score can be related to the fact that two communes (Biharia and Cetariu) doesn't have protected areas but both have, especially Cetariu, an important naturality potential which can attract tourists and different forms of weekend tourism (nature walks, cycling a.s.o.)

The highest attractivity score according to the presence of protected areas was gained by Sînmartin commune (3.5 points) on the basis of a mix of geomorphological, biogeographical and hydrological elements. Other communes have high attractivity scores, between 3-3.3 points, because of the association of plain-valley morphological elements and also because of the presence of flora and fauna elements, wetland associations. For such small-scale ecological systems one can notice an increasing interest for individual or organised forms of ecotourism, but the main requirement is not to disturb the existing ecological balance. The lower scores (1.8-2.3) can be related to areas without protected areas, the only exceptions being the corridor-like wetlands related to water courses, with own ecological identity. The vicinity of transport means can turn them proper for some forms of discovery tourism, but without a high flux of tourism.

Table 2. The score obtained by each commune of O.M.A.
related to degree of attractivity according to the existence of a protected areas

Biharia	Borş	Cetariu	Girişu de Criş	Ineu	Nojorid	Oşorhei	Paleu	Sînmartin	Sîntandrei	Toboliu	O.M.A. average
0	3	0	3	1.8	3.3	3.3	3	3.5	1.8	2.3	2.27

Quality of environmental factors

The quality of environmental factors cannot be found in the Methodology of evaluation of touristic potential, but we consider that represents, together with the climate, an important touristic resource and the presence of a less polluted environment can enhance the degree of attractivity of the rural of O.M.A.

One of the most important environmental elements affected by pollution is the air because of the very high values of the traffic. The rural of O.M.A. is crossed by a high density of road network, with an average value of 1.27 km/sqkm (highest values are in Borş, 1,81 km/sqkm and Sîntandrei, 1,91 km/sqkm). The road infrastructure is consisted of national/european roads DN 79 (E 671), DN 76 (E 79), DN1 (E 60), county and communal roads and unpaved roads. It is a fact that the urban population temporarily migrates towards the rural areas mainly because of the existence of water bodies, forests and natural protected areas.

Air quality, is monitorized mainly for Oradea. The monitoring system is made using the automated air quality monitoring network; airborne sediments measurement points; precipitation measuring points. Within Oradea the air quality indicators are generally good, the *specific indicators* - CO, SO_2, NO, NO_2, NOx, O_3, $MP_{2.5}$ and MP_{10} (metal powders), BTX (benzene, toluene, xylene), meteorological parameters, precipitation quality - being in normal limits although there are some exceedings of Maximum Allowed Quantities.[19, 20, 21]

For examples the measured values for *CO*, *NO_2,* are generally within the accepted values but the measurements made at urban measuring points BH2 (industrial measurement point located in the yard of Elementary School, Episcopia Bihor neighbourhood, Matei Corvin street no. 106/A) and BH3 measuring point (traffic measuring point, located in Nufarul neighbourhood, next to McDonalds-drive in) are constant above the accepted legal values because of the heavy traffic.[22]

In the rural area of O.M.A. is measured the impact pollution using *airborne sediments* measuring points (Biharia, Tărian, Rontău, weather station Oradea) (figure 11). According to Bihor county Environmental Protection Agency there were no exceedings of this parameter. Related to airborne sediments (MP_{10}) the measurements made at BH1 point, in 2018, were just 27 case when the values exceeded the legal values, the cause being meteorological conditions.[17]

The quality of surface waters. On the basis of quality elements (biological, hydro-morphological, chemical, physical) according to ecological and chemical state, were determined the following states:

- six quality states for rivers and natural lakes. Within O.M.A. just few brooks can be included in this category: Tășad, Uileac, Sărand;
- five quality states for water bodies highly anthropically modified (here can be included the most parts of water bodies from O.M.A.);
- three quality states for artificial water bodies (channels).

On the territory of O.M.A., the main water courses are Crișul Repede and Peţa brook.

Crişul Repede is a highly modified water body which is monitorized in three points along on a length of 34.27 km. According to indicator groups (oxygen regime, salinity, toxic pollutants, chemical indicators, biological indicators) the river water can be included at good ecological state with a high level of confidence (figure 11).[23, 24]

Peţa brook, designated as water body highly modified was evaluated as having a medium ecologic potential, because of the negative impact of population (populated areas without sewage system, the poor technical state of the sewage pipes which transport the domestic waters from Sînmartin) (figure 11).

[19] http://www.cjbihor.ro/pdf/Plan%20mentinere%20calitate%20aer%20-%202017.pdf
[20] https://zmo.ro/strategiidedezvoltare/upload/doc/56-diagnostic%20ZMO.pdf
[21] https://www.ebihoreanul.ro/stiri/ultima-or-31-41/oradea-sufocanta-masuratorile-arata-ca-in-ultimele-doua-luni-aerul-orasului-a-fost-foarte-poluat-indeosebi-in-rogerius-140251.html
[22] http://www.anpm.ro/documents/14457/3965235/Raport+preliminar+calitate+aer+2018.pdf/dcdefbee-613f-40ca-af4e-421e417dfcef
[23] http://www.oradea.ro/fisiere/subpagini_documente/129/RAPORT%20DE%20MEDIU.pdf
[24] https://zmo.ro/strategiidedezvoltare/upload/doc/56-diagnostic%20ZMO.pdf

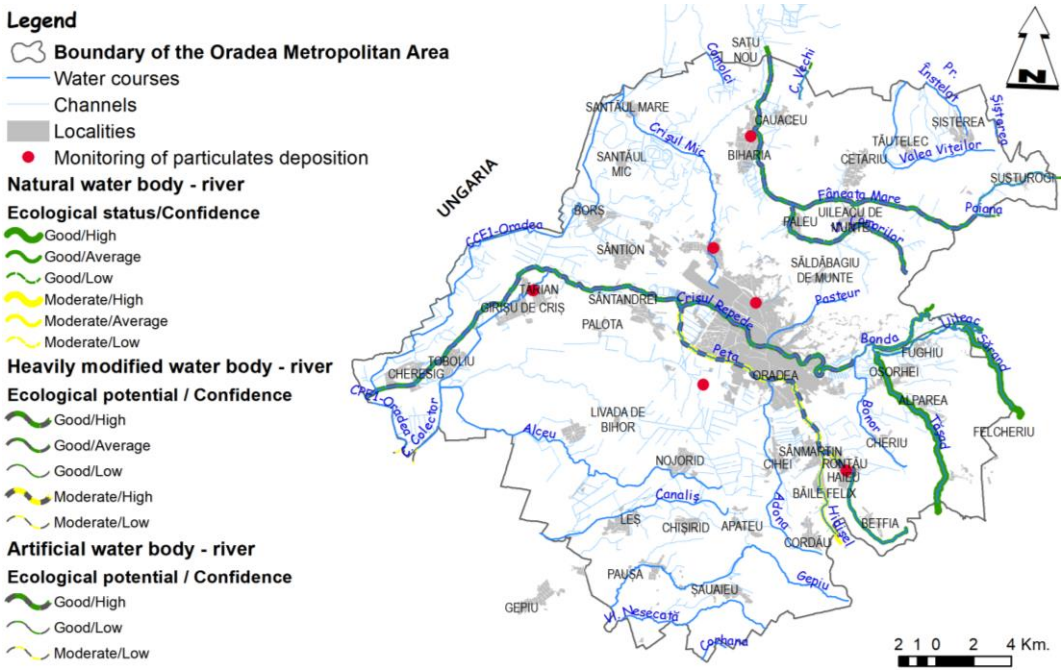

Figure 11. Water bodies quality monitoring and and air-borne sediments monitoring points
(source, updated Management Plan for Crişuri hydrographic basin 2016-2021)

CCE1 and CPE1 channels and also the Collector Channel are considered artificial water bodies with a moderate ecologic potential and low confidence.[25]

The quality of underground waters. It is important because most of the rural population from O.M.A. use the underground water as water source. The underground water is also use as water source for activities related to tourism. The research of underground water quality is made on large hydrographic basins, on morphological units, and within these, on underground water bodies, monitorized using wells.

Related to the O.M.A., the specialists from "Romanian Waters" National Administration Crişuri Branch collected samples from Biharia F1, Girişu de Criş F1, Sînmartin F1MA, Sîntandrei F1MA, Nojorid F1MA wells and, analysing the hydrostatic level concluded, that within the rural areas of O.M.A. none of water bodies are in a *poor quantitative* state.

The *nitrite (NO_3)* indicators analysed for the *free aquifer* revealed medium values which exceeded the threshold values (established by G.O. 621/2014) resulting a low chemical state for the wells from Biharia and Girişu de Criş, areas under intense agricultural use.

The *pressured* underground water body (ROCR08) was monitorized in Cheresig 1AD well, without noticing exceedings of normal parameters (Dumitru and Botău, 2011; Dumitru et al., 2010). [26]

CONCLUSIONS

The administrative territory of O.M.A. is characterised by a high number of natural protected areas, 4 nature reserves, 9 Natura 2000 sites and 2 nature monuments (*Ruscus aculeatus* and water lily). The presence of these natural elements, in a certain degree of protection and the preservation of environmental factors (a less polluted environment) can contribute to the

[25] http://www.rowater.ro/dacrisuri/Planul%20de%20Management%20Bazinal%20Crisuri/PLANUL%20DE%20MANAGEMENT%20AL%20BAZINULUI%20CRISURI%202016-2021/Plan%20Management%20s.h.%20Crisuri%202016-2021_vol.1.pdf

[26] https://zmo.ro/strategiidedezvoltare/upload/doc/56-diagnostic%20ZMO.pdf

promotion of development potential of localities, to the increase of degree of attractiveness of the rural from O.M.A. and not least the increase of the living standards of the inhabitants.

The quantitative and qualitative analysis related to environmental touristic potential within the administrative units of O.M.A. reveals a mid degree of attractivity but compensate by a naturality potential, favourable for a weekend tourism. The high values of touristic attractivity are recorded in Sînmartin, 3.5 points, Nojorid and Oșorhei, 3.3 points because in this area there is a remarcable combination of geomorphological, hydrological and biogeographical elements.

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INFLUENCE OF TERTIARY INSTITUTIONS ON THE GROWTH AND DEVELOPMENT OF A TYPICAL RURAL LOCAL GOVERNMENT AREA IN NIGERIA

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Abstract: This study assessed the impact of locating tertiary institutions on the growth and socio-economic development of selected settlements in Ife North Local Government Area (LGA) of Osun State, Nigeria. In view of this, the study identified socio-economic activities; examined factors that contributed to the growth and development; and discussed the effects of the growth and development of the selected settlements in Ife North LGA. Data for the study were obtained from both primary and secondary sources. Data were analysed using Concentration Index (CI) and descriptive statistics of mean, standard deviation and variance. Results showed that apart from the location of higher institutions, other factors that were identified as significant to the growth and development of the study area include peaceful co-existence and the creation of Ife North LGA. In addition, the impacts of the location of the institutions are mostly felt in Asipa (CI = 1.6410) and Edunabon (CI = 1.5708). However, results indicated that the most perceived influence of the location of higher institutions in the area were increase in house rent, increase in crime rates and other social vices. The private sector was found to be more active in the development of the selected settlements in Ife North LGA. In view of these observations, the study concluded that location of higher institutions of learning in the less developed parts of a developing country like Nigeria, presents both a series of challenges and openings for scholars working in urban areas. Therefore, the study recommended that, for the institutions to serve their roles as growth centres there is the need for a joint collaboration between the public and the private sectors to increase their levels of participation in the development of small urban centres.

Key words: Concentration index, growth and development, central place, regional growth pole, growth centre, small urban centres,

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INTRODUCTION

The concepts of central place and regional growth pole were developed to offer deductive explanations about the significance of service centres in a region. Christaller (1933) posited that a central place is a settlement that constitutes itself into a position of authority with respect to its control of the generators and diffusers of impulses of development. As such, other settlements that consistently have disproportionately smaller shares of the indicators than of population are regarded as peripheries or zones of influence. Therefore, the main function of a central place is to supply goods and services to the surrounding population. Its influence is undertaken with its market area and the size of this market area will determine the nature of the spatial order. However, there are some central places with location that favour them to cater for more people and offer more specialized services. Such settlements tend to grow progressively larger, their size depending on their degree of specialization, therefore producing various types of sub-centres with different populations and zones of influence.

Perroux (1955) contends that at the centre there are certain indicators of growth, or geographic agglomeration of activities as modified by Boudeville (1966), and activities whose productive capacities influence the performance of other activities in the economy. There is hardly a region without such centres, because, regional organization needs constant movement of people, goods, and information to maintain it. Weber and Puissant (2002) attributed this to the excess of inward movement that bring about change, while decreased movement leads to contractions and development of ghost cities. But growth is characteristically physical and socio-economic. Döring and Schnellenbach (2006) assert that a region is said to be growing when there is presence of increased physical and socio-economic elements such as good roads, commercial and recreational centres, health centres, industries, electricity supply, housing and institutions. Thus, the more the functions a town performs, the more rapid is the growth into a large population centre and the greater the variety of functions. This also increases the numbers of jobs it provides for the people who are attracted to it. Thus, the urban centre becomes point of intense economic activities, which in turn could extend to beyond such boundaries into the surrounding areas.

Roy (2009) corroborated by Myers (2011) observed that the growing critiques of urban theory necessarily articulate the need to generate new conceptual vectors that engage with actually existing urban conditions in the developing world. However, Swilling (2011) reiterated that in the past, spatial analysis for regional development had been constrained by three other problems: the failure to recognize the importance of spatial factors in national and regional resource development; lack of an operational framework for integrated spatial analysis; and the paucity and unreliability of data in rural regions for formulating effective development plans. Robinson and Parnell (2011) showed that as marginalized urban dwellers confront multiple inequalities and difficulties in accessing resources, they often intervene in arrangements of infrastructure in order to shift socio-environmental conditions and metabolisms of energy and other resource flows that sustain urban life.

Wei (2007) opined that the social, economic, and ecological ramifications of future development of human settlement will depend upon specific spatial patterns exhibited by the settlements in relationship to existing communities, infrastructure services, vegetation and habitat types, and watershed boundaries. But the pattern and composition of spatial systems and the roles of various types of settlements differ drastically among developing nations, and any serious effort to shape spatial systems to promote more equitable and widespread development, especially in marginal zones, requires careful analysis and planning. Dong et al. (2007) pointed out two of the dangers of inappropriate development policies in marginal regions. First, they noted that these areas are not necessarily ecologically marginal and that the ecological stability of more populated and developed regions often depends on the stability of marginal areas. Major disruptions of ecological systems in marginal areas could have adverse effects on more developed areas of the country. Moreover, if development is inappropriate or ill-considered it would likely leave people in marginal regions worse off and more alienated. Grant (2009) noted that marginal area

populations are particularly susceptible to this kind of situations because their resource systems and ways of life are often radically different from those of more developed areas. There is, therefore, a real likelihood for increased poverty, alienation and cultural disintegration under conditions of radical disruption.

The focus on the location of service centres, such as higher institutions of learning, presents both a series of challenges and openings for scholars working in urban areas, particularly in the less developed economies like Nigeria (Jinadu, 2006; Robinson, 2006; Simone, 2013). While the location of industries and other services or activities in a place could lead to rapid physical expansion and socio-economic growth, they could be used to bring development to an entire area (Simone, 2013). Tewari (1992) submitted that spatial planning of services and infrastructural facilities has become an important area of concern. He opined that concentrating investments in services and infrastructure in settlements that serve, or could serve, a large population from surrounding areas is more efficient and effective than scattering services and facilities widely over the landscape. Tewari (1992) stressed further that such method will assist regional planners and policy makers in locating services and facilities requiring different economies of scale and population thresholds in towns that could serve as growth centres for regional economic development. Edsenor and Jayne (2011) opined that location of service centres can thus be understood as in-the making, undergoing constant adjustment and intervention, and in a permanent state of flux. This ceaseless reconfiguration of urban networks is thus an important site to map conditions of possibility and from which to analyse the socio-material production of cities (Loftus, 2012; Lawhon et al., 2014).

Marianov and Serra (2004) considered the location of facilities or services in discrete space or networks that are related to the public sector, such as emergency services (ambulances, fire stations, and police units), school systems and postal facilities. They advised that when planning public facilities, it may be necessary not only to obtain a good location, but to achieve also a balanced demand assignment level. They stressed further that in order to be efficient, facilities need to have a minimum demand threshold level. Marianov and Serra (2004) particularly mentioned the provision of services that are considered merit goods, but that are services by the private sector as an area of application where the concept of threshold is relevant. According to them, this is especially relevant for merit services that have been publicly owned or controlled in several countries and are being transferred to the private sector, such as postal services, gas stations, fire departments and pharmacies. Marianov and Serra (2004) recommended that while the planner seeks to maintain good service quality by keeping a balanced spatial distribution of services, these need to have a minimum service threshold level that will allow them to survive.

Nuzir and Dewancker (2014) consider higher education institute or university as one of the important education facilities. They noted that since the ancient Greece, Rome, India, and China, education has always been a significant part of society development as the changing factor into a civilization. In a more specific manner, Nuzir and Dewancker (2014) re-echoed Japan as a country which has limited natural resources and has been experiencing aging and declining of its population. Therefore, in order to maintain its economic growth, Japan is using its science and technology advantages as its main generator. They noted that education in Japan plays important roles in the development of the economy and the society. Furthermore, they observed that the development of various education facilities contributes substantially to the development of an urban area. Nuzir and Dewancker (2014) concluded that Kitakyushu Science and Research Park is one of the examples that the coordination between the community, industries and universities is contributing to the development of Kitakyushu City.

In spite of all the afore-mentioned efforts at sustaining sustainable growth of small urban centres, growing critiques of urban theory production articulate the need to generate new conceptual vectors that engage with actually existing urban conditions (Grant, 2009; Songsore, 2009). These critiques call for additional research on the emergent urban futures being generated in the poor urban spaces. This has led to the research task of investigating socio-economic needs of

settlements undergoing development process. Planners and investors in the socio-economic systems provide important ways in which to transform, both incrementally and at a larger scale, infrastructure conditions and address multiple development issues being faced by urban centres such as small urban settlements (Robinson, 2006; Myers, 2011; Robinson and Parnell, 2011; Lawhon et al., 2014).

Hence, this study seeks to contribute to such work through a detailed reflection of informal urban systems and the influence of locating service centres, particularly, higher institutions of learning in small urban centres on the socio-economic lives of the inhabitants. In effect, the study aimed at assessing the influence of the location of higher institutions of learning on the physical growth and socio-economic development of selected settlements in Ife North Local Government Area of Osun State, Nigeria. In view of this, the study identified the types of socio-economic facilities in the selected settlements in Ife North Local Government Area of Osun State before and after the establishment of educational institutions in the area; trace-out the extent of physical growth of the study settlements before and after the establishment of educational institutions in the area; examine other factor(s) contributing to the growth and development of the study area; and discuss the effects of the growth and development of the study area.

THE STUDY AREA

The study was conducted in Ife North Local Government Area (LGA) of Osun State, Nigeria. Ife North LGA is located between latitudes 6º 58' and 7º 35'N and longitudes 4º 22' and 4º 37' E (figure 1). The LGA is made up of what is historically referred to as "Origbo meje" (Seven Sister towns) and a large number of smaller settlements. The "Seven Sister" settlements are: Moro, Yakooyo, Edunabon, Ipetumodu, Asipa, Akinlalu and Isope (figure 1). The headquarters of Ife North Local Government Area is at Ipetumodu.

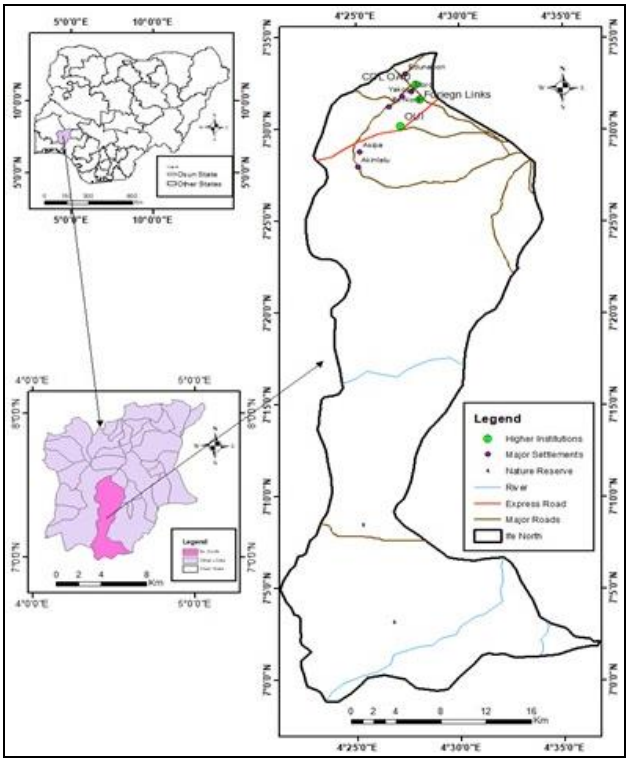

Figure 1. The Study Area

Ife North LGA has a land area of is approximately 884.906 square kilometres (Osun State, 2012). The population of inhabitants of the study area are heterogeneous in nature. The people in the study area comprised mostly of the Yoruba speaking people (Oyo, Ife and Ijesa accents). Others include some Hausa, Igbo, Urhobo, Filani etc. Human population in Ife North LGA has never been static; it has been increasing at increasing rate. In 1991, the population of the area was 127, 677 which increased to 153,694 in 2006 (National Population Commission, 1991, 2006).

The present relief of the area is a product of the past and continuous weathering process, giving rise to a considerable reduction in height in the centre of the town. Outcrops vary from place to place mainly as a result of their varying resistance to erosion but outcrops are common on granite-gneisses while they are rare on schist (Adejuwon and Jeje, 1975; Adejuwon, 2005). The area is drained by River Shasha and River Ogbe, a tributary of River Opa. The soil of Ife North is derived from the materials of old basement complex, which is mainly made up of granites, metamorphosed rocks and sedimentary rocks (Adejuwon, 2005). The most significant category of soils in the area consists of alluvial and colluvial soils along the river valleys, which is regarded as the best cocoa soils in western Nigeria (Adejuwon and Jeje, 1975; Osunade, 1992).

The Local Government Area is located within the rain forest belt of Nigeria where the climate is humid tropical characterised by high temperature, high rainfall, and high relative humidity (Adejuwon et al., 1992; Adejuwon, 2005). It is characterised by marked wet (April to October) and dry season which usually begins towards the end of October and ends around March. The mean monthly temperature ranges between 23°C and 27°C. The relative humidity is very high between 67% and 88%. This climate supports rainforest formation and encourages the growth of cash crops such as cocoa, kolanut, and oil palm (Ojo, 1977; Adejuwon et al., 1992). In effect of these geographic attributes, farming and some other kinds of agro-allied activities such as lumbering and saw-milling are the major occupations of the inhabitants of Ife North Local Government Area. Thus, the LGA is a major collection centre for agricultural products which has attracted traders from Northern Nigeria to settle and trade, especially in kolanut. Other non-farm human activities are gold-smiting, carpentry, soap making and pot making. In addition, some of the inhabitants are involved in small scale business activities.

MATERIALS AND METHODS

Data for this study were obtained from both primary and secondary sources. However, the study relied heavily on primary data which were generated through household questionnaire. Secondary data were obtained from the political map of the study area prepared by the Town Planning Division of Ife North Local Government Area (2010).

Four settlements that were directly affected by the location of higher institutions in Ife North LGA, Nigeria were selected for the study. These settlements are: Ipetumodu, Edunabon, Moro and Asipa. A total of 302 representing 5% of the total heads of households in the study area were sampled (table 1). Selection of residential housing units for the study was based on the principles of stratified sampling technique. By this, each of the selected settlements was divided into three blocks tagged A, B, and C. While Block ‘A’ represents the old core of the settlement where the oldest buildings are found, Blocks ‘B’ and ‘C’ are the intermediate and the outskirt zones, respectively. In view of the observed inequalities in the number and density of buildings and for easy identification of sample points within the study area, each of the blocks were further divided into ten quadrants of equal sizes based on the current Township Map prepared by Planning Division of Ife North LGA. In each of the cells, based on the principles of systematic sampling method employed, every kth dwelling housing unit was selected as sample point. The size of k-value depended on the number of houses contained in each cell (Eq. 1).

$$K = N/n \quad (1)$$

Where: k is the sampling interval

N is the number of households / dwelling housing unit (per settlement)

n is the number of elements contained in the sample (per street)

In every building, only the head of household was interviewed and filled a copy of the household questionnaire. However, there were exceptional cases like multi-household buildings (more than one household occupying only one building), only the oldest household (in terms of age of residing in the house) was sampled. In addition, where there was multi-building single household (a single household occupying more than one building), which is a common feature of the traditional Yoruba settlements; the head of the household was sampled.

Table 1. Sample Selection in Ife North Local Government Area

S/n	Settlement	Population		Number of Households		Sample Size (based on 2017 Estimates)
		1991 Census	2017 Estimate*	1991 Census	2017 Estimate*	
	Ipetumodu	20, 472	36, 440	1, 304	2, 320	116
	Edunabon	7, 196	12, 809	877	1, 560	78
	Moro	3, 613	6, 431	652	1, 160	58
	Asipa	2, 629	4, 680	562	1, 000	50
Total		33, 910	60, 360	3, 395	6, 040	302

* 2006 Census Results are not available on settlement basis; all estimates were based on 1991 Census Results at the official growth rate of 3% per annum.

Data obtained from various sources were analysed using statistical and cartographic methods. The influence of the location of higher institutions of learning on the physical growth of selected settlements in the study area was assessed using Concentration Index (CI, Eq. 2).

$$CI = \frac{ni \times 100}{\sum N} \Big/ \frac{pi \times 100}{\sum P} \quad (2)$$

Where, CI = Concentration Index
ni = number of facility "i" (under consideration) in location i
pi = population of location "i"
$\sum N$ = total number of facility "i" in the whole are (e.g. total sample settlements)
$\sum P$ = total population of sample settlements

RESULTS AND DISCUSSION

Table 2 shows that Ipetumodu, the administrative headquarters of the LGA, was the most populous centre in the area with 20, 472 people in 1991 which was estimated to be 36, 440 in 2017. Edunabon, the second largest settlement, contained less than half of the headquarters' population size.

Table 2. Population Growth of the Selected Settlements in Ife North LGA
Data sources: *Census Results, **Projection at official 3.0% annual growth rate (based on 1991 Census)

S/n	Settlement	1991*	2017**
1.	Ipetumodu	20, 472	36, 440
2.	Edun Abon	7, 196	12, 809
3.	Moro	3, 613	6, 431
4.	Asipa	2, 629	4, 680

SOCIO-ECONOMIC FACILITIES IN IFE NORTH LOCAL GOVERNMENT AREA

Table 3 indicates that Ipetumodu, the administrative headquarters of Ife North LGA had the highest number of socio-economic facilities in the study area. The most abundant facilities are elementary schools and supermarkets.

Table 3. Socio-Economic Facilities in Selected Settlements in Ife North LGA
Source: Field Research, 2017

S/n	FACILITIES	SETTLEMENTS				TOTAL
		Ipetumodu	Edunabon	Moro	Asipa	
1.	Daily Markets	1	0	1	0	2
2.	Periodic Market	1	1	0	1	3
3.	Supermarket	9	3	2	4	18
4.	Small Scale Industry	5	7	2	0	14
5.	Elementary School	11	9	3	3	26
6.	Sec. School	5	4	1	2	11
7.	Tertiary Institution	2	0	1	0	3
8.	Financial Institution	1	1	0	0	2
9.	Health Centre	6	3	1	2	12
10.	Post Services	1	1	0	0	2
11.	Police Station	1	1	0	0	2
12.	Electricity	1	1	1	1	4
13.	Piped-water	1	1	1	1	4
14.	Hotel/Rest House	4	4	1	2	11
15.	Tarred Road	1	1	1	1	4
16.	Students Hostels	5	1	5	2	13
17.	L. G. Secretariat	1	0	0	0	1
18.	Filling Station	4	2	1	0	7
TOTAL		**60**	**40**	**21**	**19**	**140**

Factors Influencing the Growth and Development of the Study Area

Analysis of the growth and development of selected settlements in Ife North LGA was attempted through the analyses of the roles of public and private sectors and concentration index of each of the facilities. The analysis is based on the availability and provider of the eighteen socio-economic facilities contained in table 3.

Ownership of Socio-Economic Facilities in Ife North LGA

Table 4 shows that the private sector was more active in the development of the selected settlements in Ife North LGA. However, the provision of electricity, piped water, police station, post office, Local Government Secretariat and tarred roads were solely the responsibilities of government. In like manner, markets, financial institutions, industrial establishments, hotels, filling stations and students' hostels were provided by the private sector. Of the three campuses of institutions of higher learning, two (Oduduwa University and Foreign Links) were provided by the private sector while one, OAU – Centre for Distance Learning, is owned by the Federal Government. It is important to mention that of the three public secondary schools in Ipetumodu, one is owned by the Federal Government.

Concentration Index of Socio-economic Facilities in Ife North LGA

Table 5 shows that Ipetumodu and Edunabon had the highest number of educational institutions in the study area. However, the concentration index of educational institutions was very high in Asipa and Edunabon. This implies that the impacts of the location of the institutions are mostly felt in Asipa (1.6410) and Edunabon (1.5708).

Table 4. Ownership of Socio-Economic Facilities in the Study Area
Source: Field Research, 2017

s/n	FACILITIES	Ipetumodu		Edunabon		Moro		Asipa		TOTAL
		Pub	Priv	Pub	Priv	Pub	Priv	Pub	Priv	
1.	Daily Markets	0	1	0	0	0	1	0	0	2
2.	Periodic Market	0	1	0	1	0	0	0	1	3
3.	Supermarket	0	9	0	3	0	2	0	4	18
4.	Small Scale Industry	0	5	0	7	0	2	0	0	14
5.	Elementary School	3	8	3	6	1	2	1	2	26
6.	Sec. School	3	2	1	3	1	0	1	1	12
7.	Tertiary Institution	0	2	0	0	0	1	0	0	3
8.	Financial Institution	0	1	0	1	0	0	0	0	2
9.	Health Centre	2	4	0	3	1	0	1	1	12
10.	Post Services	1	0	1	0	0	0	0	0	2
11.	Police Station	1	0	1	0	0	0	0	0	2
12.	Electricity	1	0	1	0	1	0	1	0	4
13.	Piped-water	1	0	1	0	1	0	1	0	4
14.	Hotel/Rest House	0	4	0	4	0	1	0	2	11
15.	Tarred Road	1	0	1	0	1	0	1	0	4
16.	Students Hostels	0	5	0	1	0	5	0	2	13
17.	L. G. Secretariat	1	0	0	0	0	0	0	0	1
18.	Filling Station	0	4	0	2	0	1	0	0	7
TOTAL		**14**	**46**	**9**	**31**	**6**	**15**	**6**	**13**	**140**

Pub. = facilities provided by Government (of various tiers)
Priv. = facilities provided by private individuals/community/corporate bodies

Table 5. Concentration Index of Higher Institutions in Ife North LGA
Source: Field Research, 2017

Settlements	Population	Percentage of Total (Concentration Index)					
		Educational Institutions	Health Centres	Industries	Relaxation Centres	Markets	Financial Institutions
Ipetumodu	36, 440	43.6 (0.7219)	50.0 (0.8278)	35.7 (0.5911)	36.4 (0.6026)	40.0 (0.6623)	33.3 (0.5513)
Edunabon	12, 809	33.3 (1.5708)	25.0 (1.1792)	50.0 (2.8535)	36.4 (1.7170)	20.0 (0.9434)	33.3 (1.5708)
Moro	6, 431	10.3 (0.9626)	8.3 (0.7757)	14.3 (1.3364)	9.1 (0.8505)	20.0 (1.8692)	33.3 (3.1121)
Asipa	4, 680	12.8 (1.6410)	16.7 (2.1410)	0.0 (0.0000)	18.2 (2.3333)	20.0 (2.5641)	0.0 (0.0000)

The impact of health services on the growth and development of the study area is most visible in Asipa with just two health centres. Whereas the index of concentration in Asipa is 2.1410, it is as low as 0.8278 in Ipetumodu with six health centres (table 5). Also, there were very view industrial establishments in the study area. The fourteen industrial plants were small-scale

industries such as bakery, block-making, food processing (palm oil and gaari) and local craft activities. On the whole, the concentration index of industrial activities was highest in Edunabon (2.3585) with seven establishments (table 5). Table 5 reveals further that Asipa had no industrial establishment and, thus, the concentration index was 0.0000. The concentration index of relaxation centres in Ife North LGA indicates that hotel was just the only type of such facility in the study area. There were eleven hotels in the area with Asipa having the highest index of 2.3333. The lowest impact was on Ipetumodu with four hotels and an index of 0.6026 (table 5).

In addition, table 5 shows the concentration index of markets in Ife North LGA. The markets considered in this study are the traditional open markets; both daily and periodic. The development impacts of markets were mostly felt in Asipa (2.5641) and Moro (1.8692). Ipetumodu with two markets had a concentration impact of 0.6623. Distribution of financial institutions in Ife North LGA shows that each of Ipetumodu, Edunabon, and Moro had one financial institution. The institution in Moro was necessarily one ATM centre at the CDL campus. Asipa was the only settlement among the selected ones that had no financial institution. The impact of financial institutions was highest in Moro with an index of 3.1121 (table 5).

Using descriptive statistics of mean, standard variation and variance, the contribution of the factors to the growth and development of the study area was attempted. Table 6 presents these values in descending order of mean value. The most important factor as identified by the respondents is the location of higher institutions with a mean value of 64.75, standard deviation (18.590) and variance (345.583). Peaceful co-existence and the creation of Ife North Local Government Area with the headquarters at Ipetumodu were also identified as significant factors at mean values of 48.00 and 35.25, respectively. Factors such as existence of good markets (14.75), good health services (13.75), availability of social and entertainment facilities (9.50), provision of infrastructural facilities (8.25), availability of financial institutions (3.75) and existence of industrial activities (2.00) were rated as less important to the growth and development of the study area.

Table 6. Factors Influencing Growth and Development of the Study Area
Source: Field Research, 2017

S/n	**Factors**	**Mean ± SD (Min – Max)**
1.	Location of Higher Institutions	64.8±18.6 (47 – 78)
2.	Peaceful Co-existence	48.0±21.3 (28 – 78)
3.	Creation of Local Government Area	35.3±20.8 (19 – 65)
4.	Opportunity for Business Diversification	34.8±10.8 (25 – 49)
5.	Good Life Security	25.0±9.0 (12 – 31)
6.	Cheap Land	23.5±14.5 (12 – 43)
7.	Closeness to Large Cities	19.8±1.5 (18 – 21)
8.	Existence of Good Markets	14.8±7.5 (7 – 25)
9.	Good Health Services	13.8±9.3 (1 – 23)
10.	Availability of Social and Entertainment	9.5±5.1 (2 – 13)
11.	Provision of Infrastructural Facilities	8.3±7.1 (2 – 18)
12.	Availability of Financial Institutions	3.8±5.7 (0 – 12)
13.	Existence of Industrial Activities	2.0±0.8 (1 – 3)

Socio-economic Impacts

The perceptions of respondents on the impacts of the location of higher institutions in the selected settlements in Ife North Local Government Area, Nigeria indicate multiple responses as each respondent was somewhat restricted to state, and somehow free, to select the perceived impacts. Therefore, the total responses are not equal for all cases and in all settlements.

Table 7. Perceptions of the Impacts of the Location of Higher Institutions in Ife North LGA
Source: Field Research, 2017

S/n	Influences	Mean ± SD (Min – Max)	Variance
1.	Increase in house rent	61.3 ± 17.0 (43 – 82)	288.3
2.	Increase in crime rates and other social vices	56.0 ± 13.1 (43 – 74)	172.7
3.	Diversification of business activities	47.0 ± 20.7 (25 – 75)	429.3
4.	Conversion of building/part to business premises	46.8 ± 15.0 (31 – 67)	224.3
5.	Increase in the indigenes' interest in education	35.3 ± 4.2 (31 – 41)	17.6
6.	Increase in profit	35.0 ± 21.1 (14 – 59)	444.7
7.	Restructuring of housing units to modern style	22.8 ± 11.6 (12 – 39)	134.3
8.	Provision of social facilities	17.3 ± 5.7 (11 – 23)	32.3

Table 7 presents the mean values and the standard variations of the perceptions of respondents on the impacts of the location of higher institutions in the selected settlements in Ife North Local Government Area. The most perceived influence is increase in house rent with a mean value of 61.25, standard deviation (16.978) and variance (288.250). The pair of increase in crime rates and other social vices was rated as the second important influence of the location of higher institutions of learning in Ife North LGA. It had a mean value of 56.00, standard deviation (13.140) and variance (172.667). Provision of social facilities was less significant in the assessment of influence of the location of higher institutions of learning in Ife North LGA. The mean value of this impact was just 17.25, standard deviation (5.679) and variance of 32.250. This implies that the location of higher institutions in the area has very little impact on the provision of social facilities.

DISCUSSION

This study was conducted in some selected settlements in Ife North Local Government Area of Osun State, Nigeria. The study aimed at assessing the influence of the location of higher institutions of learning on the growth and socio-economic development of selected settlements in Ife North Local Government Area of Osun State, Nigeria. To achieve this aim, the study was set against the background of identifying the types of socio-economic activities; examined factors that contributed to the growth and development; and discussing the effects of the growth and development of the selected settlements in Ife North Local Government Area of Osun State. The settlements selected for the study were those that were directly influenced by the location of higher institutions in the area. These are: Ipetumodu, Edunabon, Moro and Asipa.

The study found out that there were different kinds of socio-economic facilities in Ife North Local Government Area of Osun State, Nigeria. However, Ipetumodu, the administrative

headquarters of Ife North LGA had the highest number of socio-economic facilities in the study area. The most abundant facilities are elementary schools and supermarkets. Incidentally, these two facilities, elementary schools and supermarkets, were the most abundant in the whole area. It was also gathered that, although the provision of certain basic services like electricity, piped water, police station, post office, Local Government Secretariat and tarred roads were solely the responsibilities of government, yet the private sector was found to be more active in the development of the selected settlements in Ife North LGA. However, the provision of such amenities like markets, financial institutions, industrial establishments, hotels, filling stations and students' hostels were provided by the private sector.

Descriptive statistics of mean, standard variation and variance were adopted to explain the contributing factors to the growth and development of the study area. The most important factor as identified by the respondents is the location of higher institutions with a mean value of 64.75, standard deviation (18.590) and variance (345.583). Peaceful co-existence and the creation of Ife North Local Government Area with the headquarters at Ipetumodu were also identified as significant factors at mean values of 48.00 and 35.25, respectively. Factors such as existence of good markets (14.75), good health services (13.75), availability of social and entertainment facilities (9.50), provision of infrastructural facilities (8.25), availability of financial institutions (3.75) and existence of industrial activities (2.00) were rated as less important to the growth and development of the study area. With the Concentration Index results, it implies that the impacts of the location of higher institutions in Ife North LGA are mostly felt in Asipa (1.6410) and Edunabon (1.5708).

CONCLUSION

Based on the foregoing, it is safe to conclude that the study of the location of higher institutions of learning in the less developed country like Nigeria, presents both a series of challenges and openings for scholars working in urban areas. On the whole, this study has shown that: higher institutions could stimulate regional development when they are located as growth centres; with the results of increase in crime rates and other social vices (mean = 56.00, SD = 13.140 and variance = 172.667), it implies that the location of higher institutions could also be a threat to the residents of the area where they are located; the private sector (the community) was more concerned about their welfare than the government and despite the creation of a Local Government in the study area much has not been achieved to really assess the area as a central place.

In view of the observed laxities in the study area, the study recommends that, for the institutions to really serve their roles as growth centres there is the need for a joint collaboration between the public and the private sectors to increase their levels of participation in the development of small urban centres like the selected settlements in Ife North Local Government Area of Osun State, Nigeria. It is also recommended that, in the attempt not to disrupt the peaceful co-existence and the perceived life security in the study area, it is necessary to intensify security efforts. This, again, can be achieved through public-private collaborations.

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ASSESSING THE SIGNIFICANCE OF METEOROLOGICAL PARAMETERS TO THE MAGNITUDE OF URBAN HEAT ISLAND (UHI)

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Abstract: An assessment of the relationship of UHI Intensity with wind speed, cloud cover and relative humidity was carried out in the city of Ibadan, Nigeria. Data on wind speed, relative humidity, cloud cover, minimum, maximum and mean temperature were sourced from six weather stations from 1993-2012. To enable proper extraction of climatic parameters and ensure adequate spatial coverage, eighteen-point locations were randomly selected by dividing the study area into 40 grid cells of 1 km × 1 km across the study area. The result of regression model showed that the independent variables account for only about 52.3% of the observed variation in UHI intensity, while the F-statistic indicates there was a significant relationship between the dependent and independent variables (F_{2}^{3}= 8.806, P ≤ 0.05). It was further revealed that wind speed was found to be a significant predictor of UHI intensity with the latter weakening with increasing wind speed. Further analysis showed that at a critical wind speed of 7 m/h, UHI becomes unnoticeable. Relative humidity and cloud cover showed a negative and weak relationship with UHI Intensity. The study concluded that urban heat island intensity varies significantly and it is strongly influenced by meteorological parameters particularly wind speed. This study therefore recommends that more weather-monitoring stations and highly sensitive equipment for monitoring the climatic elements at regular intervals should be set up.

Key words: Urban Heat Island (UHI), Wind Speed, Meteorological Parameters

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INTRODUCTION

The increasing recognition of urbanization and its associated problems modify the climate of cities. These result in the climatic condition of cities being slightly different from that of the surrounding areas. Urban-induced or urban-modified weather and climate represent one of the major effects of the Urban Heat Island (UHI) phenomenon. UHI is best described as the situation where the temperature of large metropolitan cities is notably higher than the surrounding rural areas with the main cause being the modification and replacement of natural land surfaces with urban structures that possess materials which are capable of storing shortwave radiation. A study by Oke (1987) affirmed that it is a feature commonly observed in many cities, and its characteristics have been extensively studied in the past decades mostly in developed countries.

UHI has received a great deal of attention in the literatures. The scientific interest ranges from the noble work on urban effects on precipitation (Lowry, 1998) to the theoretical (Lin and Smith, 1986) and numerical (Baik et al., 2001) studies which focused on UHI effect on convection and precipitation. It is evident in these studies that an increase in the city's temperature compared to the surrounding rural suburb is of advantage in the temperate regions where winter heating bills are significantly reduced, whereas, it constitutes a disadvantage in the tropical areas as it results in climatic discomfort and impairs the well-being of city dwellers. Also, an increase in the total amount of rainfall is likely to be beneficial in period of scarce precipitation, but, otherwise in areas where excessive rainfall disrupts daily activities.

The intensity of UHI has been found to vary according to locations within the city. For example, the city centre, core areas or central business districts (CBD) impact more on the surface temperature than the suburban areas due to the increased heat capacity of the urban structures. On the nature of UHI in different cities of the world, scholars have concluded that even for cities with similar climate differences, the UHI can be explained majorly in terms of its form and location. Nasrallah et al. (1990) found the UHI of Kuwait City to be less intense than that of Phoenix, Arizona. They explain these differences in terms of the form and location of the city on the Arabian Gulf. The magnitude of urban heat island (UHI) has also been widely associated to the local meteorological factors (Kim and Baik, 2001). With regards to ambient climatic conditions, it is a common fact that UHIs strongly relate to cloud cover and wind speed such that at clear and windless night, UHI becomes prominent (Montavez et al., 2000). The intensity of UHI is proven to exhibit diurnal and seasonal cycles and this is modulated by cloud and wind conditions (Ackerman, 1985). The UHI intensity is equally reported to be pronounced during the night-time, tends to be strong in the warm seasons of the year and weak in the cold season in the tropics (Oluwamimo, 2006).

Several studies have examined the impact of some meteorological parameters such as cloud cover and wind speed on UHI intensity (Ackerman, 1985; Eliasson, 1996; Figuerola and Mazzeo, 1998; Magee et al., 1999). It is pertinent to explore this aspect of urban climate as it determines the strength and degree of UHI occurring in a city. This relationship came to limelight in the pioneering paper of Sundborg (1950) who first relate UHI intensity to meteorological elements such as wind speed, cloud cover and relative humidity using a multiple linear regression method. His work showed that wind speed and cloud cover negatively correlated with UHI intensity in Uppsala, Sweden. It is obvious from this revelation that majority of these studies were carried out in more developed parts of the world (Auer, 1981; Ackerman, 1985; Morris et al., 2001; Chow and Roth, 2006; Fortuniak et al., 2006; Yow and Carbone, 2006) but very few studies if any, in sub-Saharan region of Africa have assessed the role of meteorological parameters in the intensity of UHI. The available ones (Robaa, 2003; Enete et al., 2012) engaged traditional method by examining temperature difference between urban and rural sites but this study clearly departs from the convention in that it combines the traditional approach of monitoring UHI with a satellite-based methodology. Against this backdrop, the study assessed the significance of meteorological parameters to the magnitude of UHI in Ibadan, Nigeria. The choice of Ibadan City was because of its expansion as the largest metropolis in West Africa.

STUDY AREA

Ibadan is located within Latitude 7º 15ˈN and 7º 30ˈN of the Equator and Longitude 3º 45ˈE and 4º 00ˈE of the Greenwich Meridian. Ibadan is located near the forest-grassland boundary of south-western Nigeria. Ibadan metropolis currently hosts the administrative capital of Oyo state. Generally, five local government areas (LGAs) make up Ibadan metropolis out of eleven that makes Ibadan region and these are Ibadan North, Ibadan Northwest, Ibadan Northeast, Ibadan Southeast, and Ibadan Southwest while the six Peri-urban LGAs are Egbeda, Akinyele, Ido, Ona-Ara, Oluyole, Lagelu. In view of its location, the climate of the study area is that of a tropical wet and dry climate. Largely, it is strongly influenced by the West African monsoon climate, marked by a distinct seasonal shift in the wind pattern, radiation and cloud cover due to its latitudinal location. The two most defined rainfall seasons are the dry and wet season. The period of wet season is usually between March and October when the area is under the influence of the prevailing moist, maritime south-west monsoon winds which blow inland from the Atlantic Ocean while the dry season occurs normally from November to February when the dry, dust-laden north-east trade winds blow from the Sahara Desert. The mean annual rainfall of Ibadan is about 1205 mm, falling in approximately 109 days. The temperature of Ibadan is characterized by constant high temperatures throughout the year with mean monthly temperature fluctuating around 26.6ºC, while the mean monthly minimum and maximum temperature is rarely below 21.4ºC. Highest temperatures usually occur around February and March which coincides with the period that mark the end of the dry season. Relative humidity is constantly high throughout the year with annual average greater than 80 percent, and the period of highest relative humidity coincide with the rainy season. The cloud cover is high with about 80 percent in the rainy season (Adebayo, 1985).

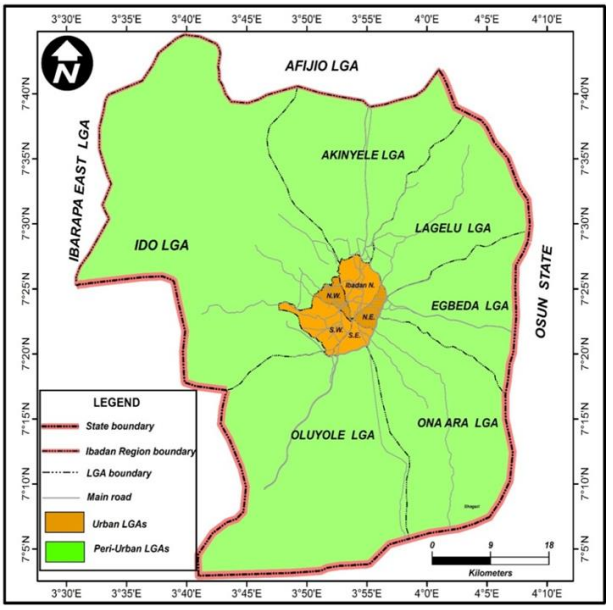

Figure 1. Map Showing the Study Area (Ibadan Metropolis and its Peri-Urban Areas)
Source: Digitized from Google Earth Pro. (2015)

The city is the largest in Tropical Africa and the largest indigenous metropolitan area in sub-Saharan Africa (Adedimeji et al., 2008). Ibadan's population grew from an estimated figure of 170,000 in 1911 to 459,196 in 1952. By 1963, its population had reached 625,000. The 1991 census put the population of the city at about 1.45 million people. Together, the region of Ibadan has a population of over 2,550,593 persons according to the 2006 population census. The Ibadan

metropolis local government areas account for 1,338,659 persons, while the six other local government areas that constitute the rest of the region account for slightly less than one-third of the population for the state (National Population Commission, 2006). The total area of developed land in Ibadan increased from 100 ha in 1830 to 12 km^2 in 1931. But by the mid-twentieth century, the contiguously built-up area of Ibadan grew from 30 km^2 in 1963 to 214 km^2 in 1988 (Oluseyi, 2006). By the year 2000, it expanded covering an area of about 400 km^2. The expansion of the urban area in terms of its growth during the latter half of the 20th century (from 40 km^2 to 250 km^2 in the 1950s and 1990s respectively) reveals that there has been an underestimation of the total growth of the region, and its locational advantage made it a favorable city for educational, socio-political, commercial and industrial activities.

MATERIALS AND METHODS

As shown in table 1 and figure 2 weather data were obtained from both the conventional and point locations (satellite extract). The ground-based weather station consists of the agricultural and meteorological stations which are the Geospatial Unit of the International Institute of Tropical Agriculture (IITA), Cocoa Research Institute of Nigeria (CRIN), Institute of Agricultural Research and Training weather unit (IARandT), Forestry Research Institute of Nigeria (FRIN) and Ibadan Airport (through: Nigeria Meteorological Station (NIMET).

Table 1. The Name of Weather Stations and their Geographical Attributes
Source: Authors field Survey, 2015

S/N	Station Name	Type	Latitude	Longitude	Elevation (m)
1	NIMET	Synoptic Station	7^0 26' 45.0"	3^0 53' 26.0"	197 m
2	CRIN	Agro-climatological Station	7^0 14' 58.0"	3^0 50' 56.2"	130 m
3	IAR and T	Agro-climatological Station	7^0 22' 46.2"	3^0 50' 37.7"	146 m
4	IITA	Agro-climatological Station	7^0 29' 48.0"	3^0 54' 12.4"	211 m
5	FRIN	Agro-climatological Station	7^0 23' 30.9"	3^0 51' 47.7"	187 m
6	NIHORT	Agro-climatological Station	7^0 24' 21.6"	3^0 51' 03.0"	200 m

"Index of UHI Intensity" is a technique most commonly used to detect the influence of urbanization on the climate of urban centres which considers the difference in temperature between a representative of urban and rural station (Yague et al., 1991; Jauregui et al., 1992; Karaca et al., 1995). This study therefore chooses Cocoa Research Institute of Nigeria (CRIN) as rural reference station and the difference in temperature between the rural site and urban stations (average temperature) were used as a surrogate measure of the urban heat island intensity in Ibadan. The choice of the reference station is based on the fact that only the green areas in the city were observed to have the lowest temperatures. The only station that closely approximates this feature is the weather station in Idi-Ayunre. The station was therefore considered as a baseline to assess UHIs at other stations. Data on wind speed, relative humidity, cloud cover, minimum, maximum and mean temperature were obtained from the stations for a period of twenty years (1993-2012).

In addition to the climatic data sourced from the ground weather stations, satellite data were also obtained to ensure adequate spatial coverage of the study area. In achieving this, the dataset was first of all downscaled to the study area. The entire area was divided into 40 grid cells (or pixels) of 1 km × 1 km. Using the 'Fish-net' technique in the ArcGISTM software, point locations were randomly selected and the weather data for each point were extracted so as to get a good representation of the terrains therein. Going by the conclusions by Mohan et al., (2012) who used 32 km × 32 km grids in their analysis, these are expected to provide accurate measurements of UHI intensity and provide a basis for comparison with in situ measurements which can be used to detect major hotspots and for assessing hotspots for other sites and times when in situ measurements are inadequately available. Overall, twenty-four (24) sites were chosen throughout the city which include the six conventional ground station (WS) and eighteen points of satellite data extract. Figure 2 shows the location of the sampled sites on the map of Ibadan. The data

extracted are entered into relevant software such as Microsoft Excel Professional Plus 2013, Statistical Package for the Social Sciences (SPSS) and other statistical tools.

Statistically, multiple regression analysis was used to assess the effects of each meteorological parameter on the intensity of UHI in Ibadan. The UHI intensity (which is the dependent variable) was regressed on the three meteorological elements (predictors). It is aimed at establishing the level of relationship as well as the contribution of each meteorological parameter to the observed heat island intensity.

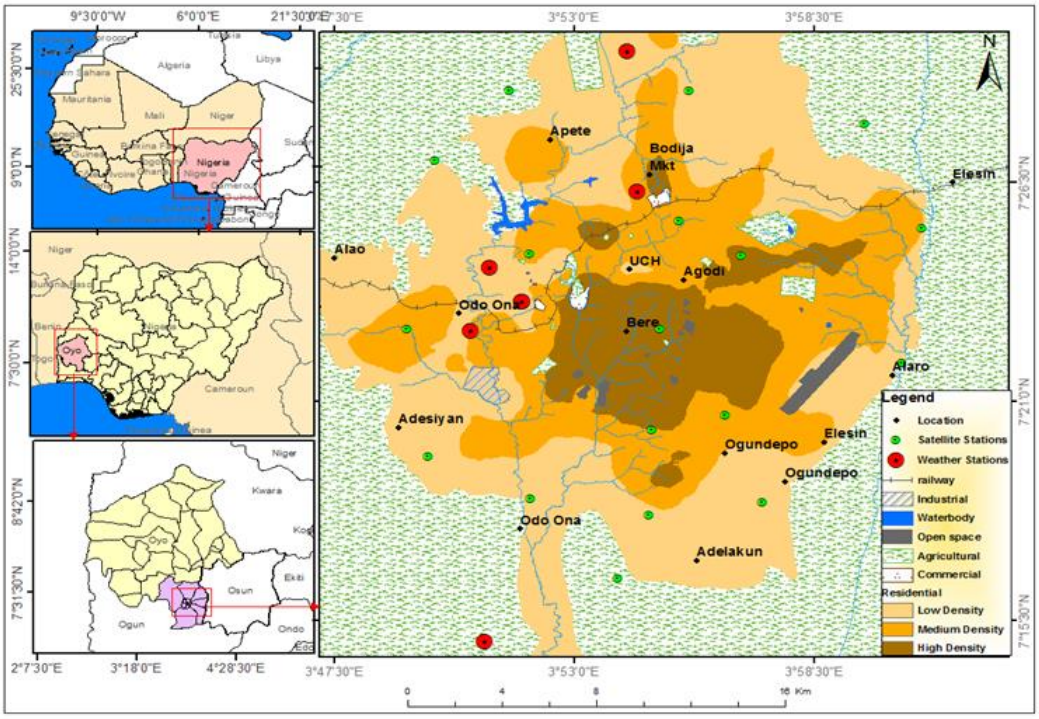

Figure 2. Locations of Satellite Data Extract and Weather Stations across the Study Area
Source: Digitized from Google Earth Pro. (2015)

RESULTS AND DISCUSSION

Urban heat island intensity is closely related to the prevailing meteorological conditions. Numerous studies have shown the impact of meteorological parameters such as cloud cover and wind speed on the intensity of UHI (Ackerman, 1985; Eliasson, 1996; Figuerola and Mazzeo, 1998; Magee et al., 1999; Mohan et al., 2012). Here, UHI intensities were compared with relevant meteorological parameters to determine if similar relationship exists.

Significance of Wind Speed on Urban Heat Island Intensity

Wind speed is an important parameter in urban areas influencing the health, outdoor/indoor comfort, air quality and energy consumption. In relation to ambient climatic conditions, wind speed largely impacts the magnitude of UHI. High winds influence the cooling difference between the urban and Peri-urban areas and thus, reduces the UHI effect. Conversely, calm conditions with clear skies create room for large UHI effect.

In figure 3, UHI is related to the wind speed (table 4). As the wind speed increases, the UHI intensity presents a tendency to decrease as there is an inverse relationship between wind speed and UHI intensity. The R^2 value shows that wind speed only explains about 33.5% variation in UHI intensity while about 66.5% is left unaccounted for. It would be observed that the maximum UHI

intensity actually began to decline for wind speeds greater than 3 m/h. However, just like other cities, higher magnitudes of UHI intensity in Ibadan were observed to occur during situations of atmospheric calm. In fact, the highest magnitude of UHI intensity occurred with winds of 2 to 4 m/h (66.7%).

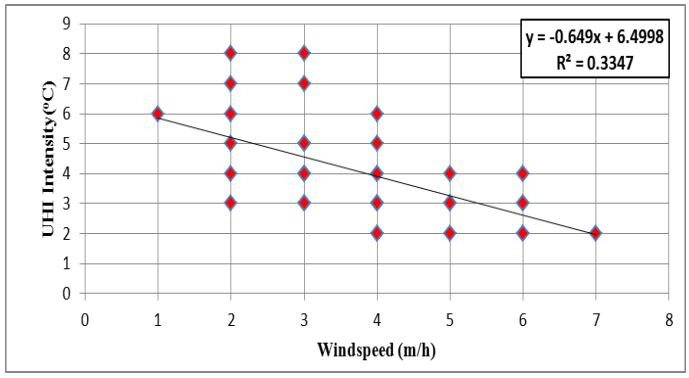

Figure 3. Relationship between Mean Wind Speed and UHI Intensity
Source: Authors field Survey, 2015

In addition, the strong UHI intensity (>4°C) occur, more frequently, with winds between 2 to 4 m/h (54.2%) and 4 to 6 m/h (21%) whilst, the thermal contrasts between the two sites seem to disappear for very strong winds (>7°C). This condition suggests that there can be a critical wind speed beyond which the UHI phenomenon becomes unnoticeable. If the threshold of 2°C is considered as a case indicative of the absence of UHI, the critical wind speed is approximately 7 m/h. This therefore supports the claim that very strong winds prevent the development of the UHI. Winds of about 6 and 7 m/s (13.3 and 15.5 m/h) are critical values for the existence of the maximum UHI intensity in Seoul, South Korea and Salamanca, Spain (Kim and Baik, 2001; Alonso et al., 2003). It was also discovered that UHI occurred with winds in every direction. However, strong UHI intensity occurs more frequently with south western and south-south western winds.

Significance of Relative Humidity on Urban Heat Island Intensity

Humidity is a term that describes the amount of water vapour in the air. It is one of the important factors that influence the energy budget and human physiologic comfort (Adebayo, 1985). The result from figure 4 showed that, similar to wind speed, relative humidity negatively correlates with UHI intensity, although the relationship is very weak (R^2= 12%) meaning that the UHI intensity is weakened as relative humidity increases.

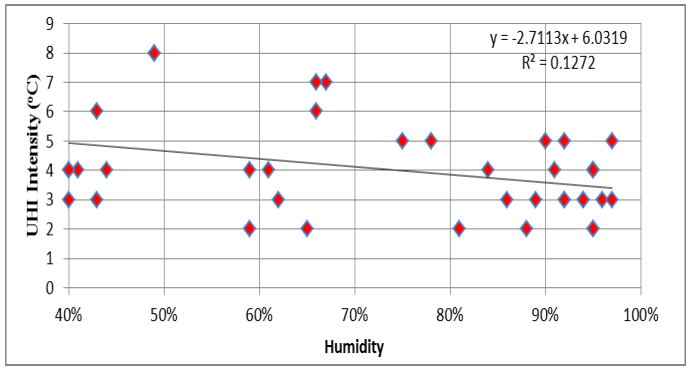

Figure 4. Relationship between Humidity and UHI Intensity
Source: Authors field Survey, 2015

It is also obvious in the scatter plot in figure 4 that much larger magnitudes of UHI intensity in Ibadan was observed to occur during conditions of high relative humidity, i.e. 72% of the total data exists in the 60-100% relative humidity range. This also explains why the heat island intensity of between 4.5-5.0ºC were reported at the midnight and early morning of the observation period when the atmosphere is more humid and cooler. The highest magnitude of UHI intensity (8.0ºC) occurred during conditions of dryness or hot afternoons when the air is less humid (40-50%). This condition could be due to the fact that when evaporation from the urban surface takes place, the surface air temperature decreases because of evaporative cooling, and the amount of vapour in the air (relative humidity) increases because of an increase in the water vapour pressure. This, perhaps, explains the reason why UHI intensity tends to decrease as the relative humidity increases in Ibadan.

Table 2. Relationship between UHI and Mean Daily Wind Speed, Relative Humidity and Cloud Cover (Based on 40-Day Sample between October-December, 2014)
Source: Authors field Survey, 2015

S/N	UHI (ºC)	Cloud Cover (oktas)	Wind speed (m/h)	Humidity (%)
1	3	0.39	3	94
2	3	0.36	2	96
3	5	0.36	2	97
4	7	0.11	3	67
5	6	0.06	4	43
6	4	0.22	3	40
7	3	0.12	6	62
8	4	0.05	5	84
9	2	0.55	4	95
10	4	0.68	4	95
11	5	0.67	4	92
12	5	0.63	3	75
13	8	0.15	3	49
14	3	0.21	3	40
15	4	0.1	6	61
16	3	0.32	5	89
17	4	0.73	4	95
18	3	0.7	3	92
19	5	0.62	3	90
20	5	0.76	3	78
21	8	0.17	2	49
22	4	0.21	2	41
23	4	0.12	6	59
24	2	0.29	6	88
25	3	1	4	97
26	3	0.76	4	92
27	4	0.75	3	91
28	6	0.57	2	66
29	4	0.1	3	44
30	3	0.28	5	43
31	2	0.16	7	65
32	3	0.11	6	86
33	3	0.16	4	94
34	2	0.13	4	95
35	4	0.11	3	95
36	7	0.02	2	66
37	6	0.14	1	39
38	4	0.26	3	40
39	2	0.17	6	59
40	2	0.12	5	81

Relationship of Urban Heat Island with Wind Speed, Relative Humidity and Cloud Cover

Table 4 presents the relationship between Urban Heat Island Intensity (UHII) and wind speed, relative humidity and cloud cover.

Table 3. Result of Multiple Regression Statistics
Source: Authors field Survey, 2015

Multiple R = 0.651 Multiple R^2 = 0.523 Multiple R^2 (Adjusted) = 0.475 Std. Error of the Estimate = 1.278					
Sources of variation	**Sum of Squares**	**df**	**Mean Square**	**F-Ratio**	**P**
Regression	43.130	3	14.377	8.806	0.000[a]
Residual	58.770	36	1.633		0.000[a]
Total	101.900	39			0.000[a]

a. Predictors: (Constant), Cloud, Wind, Humidity

b. Dependent Variable: UHI

Table 4. Result of Multiple Regression Statistics
Source: Authors field Survey, 2015

	Unstandardized Coefficients		**Standardized Coefficients**	**t**	**Sig.**
1 Model	**B**	**Std. Error**	**Beta**		
(Constant)	7.993	.863		9.259	.000
Wind	-.631	.149	-.562	-4.226	.000
Humidity	-.019	.012	-.255	-1.664	.105

a. Dependent Variable: UHI

The regression equation obtained from the analysis presented in table 4 is given as;

$$Y=7.993-0.631X_1-0.19X_2-0.004X_3 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, Y = Urban Heat Island Intensity

X_1= Wind speed

X_2 = Humidity

X_3= Cloud cover

The regression model obtained from the analysis as presented in table 4 shows that the three independent variables (wind speed, relative humidity and cloud cover) account for 52.3% of the explanation of urban heat island intensity (i.e. the model summary shows that R_2= 0.523). This suggests that other relevant predictors, including those related to synoptic weather, anthropogenic heat and atmospheric pollutants need to be included to increase the variance explained. The F-statistic from the ANOVA (8.806) has a high significance value indicating that the model significantly explains changes in the dependent variable (UHI Intensity). This implies that UHI Intensity is related to wind speed, relative humidity and cloud cover. However, the interpretation of the individual 'b' values shows that only wind speed is a significant predictor of UHI Intensity while relative humidity and cloud cover were not. From equation 1, it can be seen that a unit change in wind speed leads to a change of almost eight times over in the value of UHI Intensity. Wind speed was also found to have a much higher influence on UHI Intensity as indicated by the highest beta weights associated with the parameter (0.631). Relative humidity is the second highest predictor (0.019) while cloud cover is the least of the three important predictors (0.004).

CONCLUSION

A key component of the study was an assessment of the contribution of meteorological parameters to the magnitude of urban heat island over the study location. UHI Intensity was

regressed against wind speed, relative humidity and cloud cover to establish the contribution of the meteorological variables to UHI and a regression model was obtained to show this contribution. Of the three meteorological variables, only wind speed and relative humidity were found to be statistically significant while cloud cover was observed not to be significant. The relationship between wind speed and UHI was found to be a strong, inverse one and this confirms what obtains in theory that as wind speed increases, UHI intensity tends to be weakened. The R-squared value of the regression analysis between meteorological variables and UHI Intensity established that only about 52.3% of the observed variation in UHI Intensity is explained by the meteorological variables used in the study. It was therefore concluded that other factors such as the prevailing synoptic weather, anthropogenic heat and atmospheric pollutants etc. (which account for about 48%) could significantly influence the magnitude and characteristics of the UHI as reported in the literature. This study therefore recommended that more weather-monitoring stations and highly sensitive equipment for monitoring the climatic elements at regular intervals should be set up.

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PROSPECT STUDY OF THE CELLARS IN SĂLACEA, BIHOR COUNTY, ROMANIA

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Abstract: Globalisation is considered to be a defining phenomenon for the present society having a decisive impact in the outlining and evolution of local identiy elements. The main purpose of the study is to localise, record and analyse the cellars found in Sălacea in order to preserve, promote and profit from their use in tourism. The methods used were the study of the speciality literature and onsite visits. Therefore, a series of specific software programs were used, the results having created a digital data base which may be considered as an informational support for other scientific procedures, including the identification of a series of opportunities for local development.

Key words: local identity, cellars, tourism, local development

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INTRODUCTION

Sălacea is the residence village of the commune bearing the same name, located in the Northern part of Bihor County, Romania. The village is located in the area which connects Câmpia Ier's Lower Meadow and Salacea's Hills, a diverse natural habitat which gives the area a complex economic characteristic, based on the culture of plants, commerce, fishing and animal breeding.

The favourable topoclimate conditions of this habitat (Șerban, 2010; Sabău, 1997) are well highlighted through the multi-secular occupations of the local population (defining Sălacea, as well as the entire Ier Valley) connected to the cultivation of grapes and wine production. As evidence for this long and old oenological tradition are the great number of cellars dug within the

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hills which border the village in its Southern part. The architectural elements which compose the structure of the cellars, physically transfer a series of cultural and ethnographic values as well as specific features of the location as well as of the local community.

The identity and specificity features given by the cellars in Sălacea, are brought forward by their large number (approximately 956; according to Keri and Kantor, 2009), their layout in lines which make up real streets of cellars independent from the households, as well by their distinct architecture (Lincu et al., 2018). All these features give them a kind originality and uniqueness differentiating them from other such constructions (cellars) in Ier Valley.

Originally the cellars were dug in order to preserve the wine in favourable environment for a longer period of time as well as storing the tools used for the oenological procedures. Later on, as the vine surfaces were reduced, the cellars were used as storing places for fruit and vegetables as well as for the tools used to work the land.

For the local people, the cellars represented for a long period of time an integral part of their social and cultural life as well as a way of showing off their wealth (Iren, 2003). Therefore, the number and size of the cellars owned by a family were in direct proportion to its wealth (Lincu et al., 2018).

Considering therefore all of the above, it is safe to say that the cellars represent valuable testimonials with historical values supplying essential pieces along with other categories of anthropic resources (Ilieș et al., 2010; Ilieș et al., 2016; Stașac and Herman, 2010; Tătar and Herman, 2013), of information regarding the past of Sălacea, traditions, culture and habits, contributing massively to the creation of a spatial identity of the place (Herman and Wendt, 2011; Herman, 2012; Ilieș et al., 2017). Being the beneficiary of a series of essential attributes (age, uniqueness, innovation, functionality, representation, etc.) the cellars are latent touristic resources with a great potential in the genesis evolution and dynamics of the local tourism (Herman et al., 2017; Ilie et al., 2017; Herman et al., 2018b).

The analysis of the speciality literature concerning the studied habitat it reveals the existence of several studies which deal with the particularities of the natural (Ilieș et al., 2017; Herman et al., 2016; Czirjak, 2014; Ardelean and Karacsonyi, 2002; Szilagyi et al., 2012) and socio-cultural environment of Sălacea (Ilieș et al., 2014; Iren, 2003; Indrie et al., 2019; Keri and Kantor, 2009; Keri, 2015).

Wine cellars do not represent a new study subject, the cellars being found among the research concerns of several authors (Linc et al., 2017; Dincă et al., 2012; Fernandes and Cruz, 2016; Martins et al., 2017; Lincu et al., 2018).

Despite the fact, the role and importance of the cellars for the rural society are still unknown to the large public, not mentioning their historic role and importance in outlining the identity specific to the place as a basic support in affirming and developing tourism as a durable alternative for a responsible capitalisation of the territory (Herman and Gherman, 2016; Herman and Benchiș, 2017; Herman et al., 2018a).

Based on this background, the main purpose of the present study is to carry out an inventory of the cellars independent of the households in Sălacea village, in order to create a data base (photos, audio-video materials, drawings, graphic materials and cartographic projections) which should be used as informational support for other scientific procedures, including here the possibility to identify opportunities for local development.

RESEARCH METHOD

The present study brings forward the results of the researches comprised by the speciality literature and carried out on site. Four on site research expeditions were carried out between the 15th of April and the 20th of April 2019 in order to identify and map all the cellars. The mapping was carried out using the spatial coordinates' identification method for each cellar, i.e. latitude and longitude, using the Magellan eXplorist 310. The analysis of the particularities of the territory and the mapping supposed the use of the following software programs: 3D Map Generator and ArcMap 10.6. The cartographic materials, as well as the photographic data base resulted after the onsite researches were processed in Adobe Photoshop CC 2015.5 and CorelDRAW X7.

RESULTS AND DISCUSSIONS

Sălacea is also called "the village of 1000 cellars", an allusion to the high number of such constructions being present on site. The number of cellars in Sălacea is a rather controversial subject, as from the discussions had on site most of the locals claim that their number exceeds 900, while others declare that "Sălacea comprises more cellars than houses". A rather similar situation results therefore from the analysis of the speciality literature, where a number of 956 cellars is mentioned (Keri and Kantor, 2009).

The scope of the researches in the field was to highlight the exact location of each and every cellar, create an inventory regarding their number and their association in agglomerations and "alleys", streets with cellars as well as their access (rods, pedestrians) in order to capitalise them inthrough tourism.

Therefore, after having carried out the researches in the field, a number of 594 independent cellars were identified, all being dug within the slopes of the hills on the Southern side of the locality (figure 1, table 1).

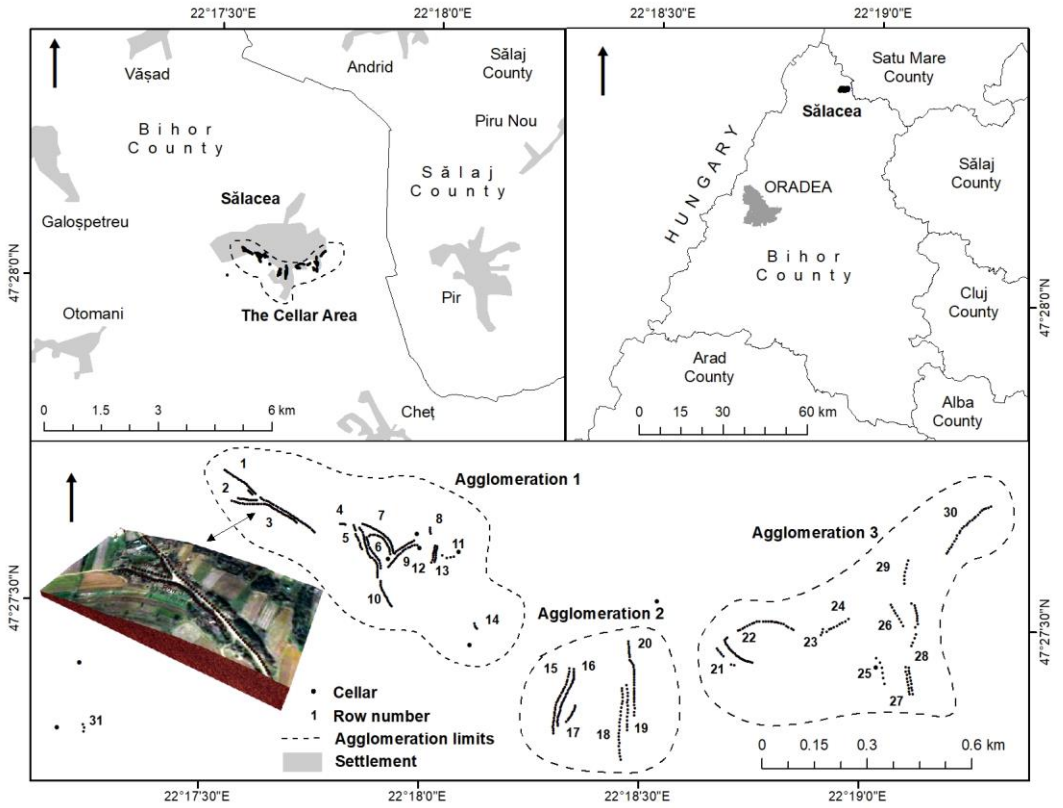

Figure 1. The spatial repartition of cellars within Sălacea

It has to be mentioned that some cellars were omitted during the inventory, and we are talking here about those cellars located on private land, inside the villagers' gardens, where the access was either restricted or in some cases forbidden. Therefore, it is safe to say that their touristic potential (i.e. of the cellars within the households) is very limited.

The general analysis of the cellars in Sălacea reveals the existence of three main agglomerations. The largest agglomeration (considering the number of cellars comprised) is

located in the South-Western part of the village, comprising 14 rows of cellars, respectively 295 cellars (i.e. 21.1 units / row). The second largest agglomeration is located in the Southern part of the village and comprises 6 rows, respectively 147 units (24.5 units / row). The South-Eastern agglomeration Sălacea has the largest territorial expansion, comprises 10 rows of 146 units, the average being 14.6 cellars / row. Next to the three agglomerations, another 6 isolated cellars were identified, located outside the territory of the village (table 1).

The analysis of the rows considering the number of cellars reveals the predominance of rows 1 (56 units), 22 (48 units), 3 (39 units), while at the opposite pole there are rows 23 and 31 (with 3 units each), 8, 11 and 14 (with 4 units each) and 25 (6 units) (table 1).

Table 1. Centralising table regarding the cellars in Sălacea Village, Bihor County

Agglomerations	Number of rows	Rows code	Number of cellars	Road structure	Road category
Agglomeration 1	13	1	56	paved	II
		2	16	paved	II
		3	39	paved	II
		4	17	ground	II
		5	30	paved	II
		6	34	paved	II
		7	38	paved	II
		8	4	paved	II
		9	18	paved	II
		10	17	paved	II
		11	4	paved	III
		12	9	ground	III
		13	9	ground	III
Agglomeration 2	7	14	4	asphalted	I
		15	30	asphalted	I
		16	32	asphalted	I
		17	11	paved	II
		18	22	paved	II
		19	14	ground	IV
		20	32	ground	IV
Agglomeration 3	10	21	7	ground	IV
		22	48	paved	III
		23	3	ground	IV
		24	9	ground	IV
		25	6	ground	IV
		26	8	asphalted	I
		27	9	paved	II
		28	23	paved	II
		29	7	ground	IV
		30	25	ground	IV
Isolated	1	31	3	ground	IV

Access represent a fundamental criterion for the capitalisation of these elements through tourism. Therefore, the streets which include cellars are favoured by their positioning in the immediate proximity of the main street alignment, being connected either direct or through a series of connecting alleys. If there is an easy pedestrian or bike access, the access by car is difficult due to the geographical layout and the impracticable roads.

The analysis of the rows of cellars concerning the access roads' surface reveals the existence of three cases: asphalted streets (4 rows of cellars), paved streets (15 rows) and ground streets (12 rows) (table 1, figures 2-4).

Figure 2. Asphalted street

Figure 3. Paved street

Figure 4. Ground street

After the field research and analysis, the rows of cellars were divided into four categories considering the practicability degree of the access road for vehicles especially cars. The 1st category includes 4 rows which are located on asphalted streets with easy access, 2nd category is the largest category as it includes 14 units and it is individualised by paved roads with a rather good access independent on the season or the weather conditions. The roads which comprise the four rows of cellars (4, 5, 6, 22) depend on the weather conditions and they belong to the 3rd category. A low quality of the roads is recorded for the 2nd and 3rd agglomerations (4th category – 9 rows), being therefore represented by narrow pathways with the rows of the cellars only on one side, usually inaccessible for vehicle all year round (table 1).

CONCLUSIONS

The cellars in Sălacea village have a great historical and architectural value, their structure comprising important specific local elements. The appearance and development as well of the three agglomerations of cellars, spread on 31 rows, 594 cellars represent a reflex, an imposed condition by the natural environment on one hand and by the socio-economical context on the other. Their economic and symbolic value, doubled by the relatively easy access and their proximity to Oradea may considered as strengths in the development of the local economy based on the capitalisation of such local identity elements. Independent cellars have a great impact in outlining the identity of Sălacea Village, on Ier Valley, Bihor County, Romania. These are vivid testimonials of a universe lost in the blur of time, a world where the habits and traditions were kept to the book and where under the more and more acute pressure of globalisation risks of becoming one with the past.

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ASSESSMENT OF TOTAL ATMOSPHERIC DEPOSITIONS (TAD) IN AKURE, ONDO STATE, NIGERIA

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Abstract: The aim of the study was to evaluate the TAD of Akure, Ondo State, Nigeria. In this study, rainwater samples were collected monthly in a polyethylene container attached to a funnel for a period of twelve (12) months at 40 designated sites (residential, industrial, and traffic-related areas). The rainwater samples were filtered, the masses of TAD on the filter paper were determined gravimetrically, and atmospheric deposition rates were calculated. Meteorological data were measured at a monitoring site at the Department of Meteorology, Federal University of Technology, Akure, Ondo State, Nigeria. From the results obtained in this study, it was observed that deposition rated ranged between 5 and 427 µg/m^2. The average temperatures, wind speed, relative humidity, rainfall and wind direction for the periods were 25.00^{o}C, 0.63 mph, 83.74%, 0.03mm and 117.43^{o}C (2015) and 26.2 ^{o}C, 0.74mph, 81.89%, 0.92mm, 118.32^o (2016). There were relationships between TAD and meteorological parameters. The results showed that TAD in many parts of the studied areas exceeded the World Health Organization guideline standards (350 µg/m^2).

Key words: Air pollution, urbanization, mega cities, gravimetrical, limit,

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INTRODUCTION

The global air quality is worsening to an alarming rate. Population growth, anthropogenic activities, increase in vehicular movement, land use development, industrialization, and urbanization severely affect the air quality. One of the requirements of living things is clean air, especially human (Herman, 2009; Ndamitso et al., 2016). Despite the efforts in the introduction of

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cleaner technologies and tighter emission controls in different countries, air pollution remains a major health risk. Also, TAD reduces atmospheric visibility and affects the state of different cultural heritages (Van Grieken and Delalieux, 2004). According to the IPCC (2001), on a global scale, TAD influences the Earth's radiation energy balance, which can impact on global climate change (Tasic et al., 2008).

During raining seasons, particles in the air are either aggregated or dissolved. When atmospheric deposition occurs, dry and wet depositions take place (Puente et al., 2013). Dry deposition of particles takes place by direct impact and gravitational settling on land or water surfaces, while in wet deposition, aerosols and gases are dissolved or suspended in water droplets or ice crystals (Azimi et al., 2003). According to Abulude (2006), atmospheric dust is a problem in Nigeria therefore, it needs attention.

Akure is an urban state capital in Nigeria and so has a steady growth in industrialization and urban development. The record of TAD in Akure, Ondo State has not been explored yet and documented well. According to Furuuchi et al., (2010), in order to employ effective methodologies for controlling or reducing environmental loads, it is important to know the status of air pollution and contributions from emission sources. To allay the fear of air pollution, it will be necessary to conduct this study. The objective of this study was to validate monthly sampling procedure in the sampling locations, focusing on the assessment of total atmospheric deposition. During the twelve months, the atmospheric fallout was obtained monthly.

MATERIALS AND METHODS

SAMPLING AREA

The samples were collected in Akure, Ondo State, Nigeria (N07^{o} 15' 46.2' E005^{o} 14' 29.1 ± 9ft). Samples were collected for a period of twelve (12) months (July 2015 to June 2016). Figure 1 depicted the map of the location.

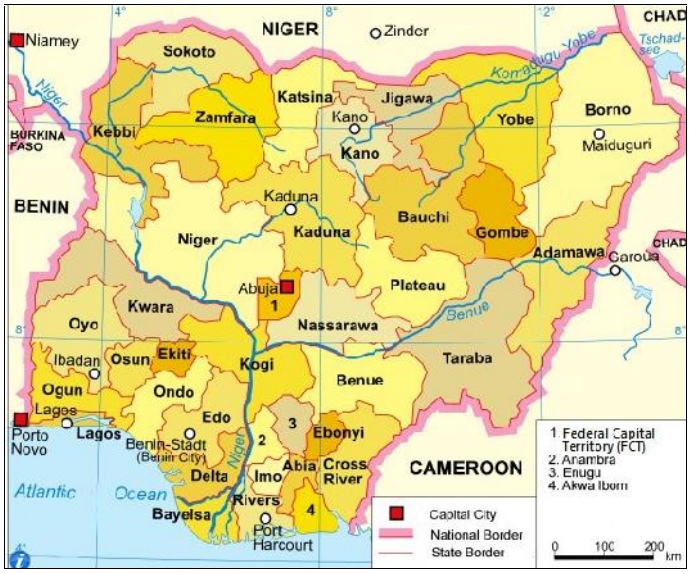

Figure 1. Map of Study Area

SAMPLE COLLECTION

The aim of the study was to analyze the TAD in Akure, Ondo State, Nigeria. Standard methods used by Onwudiegwu et al. (2016) was employed. Eleven locations were identified with a total of 40 sites. The choice of the locations was based on the followings: industrial, high traffic

density, road construction, and residential (control). The sampler was placed at each site at a height of 1.5 meters above the ground level. A total of 480 samples was collected at a monthly interval, plastic funnels thoroughly washed into the plastic container with de-ionized water, filtered with Whatman Ashless filter paper, dried in a ventilated oven, and weight determined. Deposition rates were calculated. TAD volumes were obtained using a measuring cylinder before and after days of exposure.

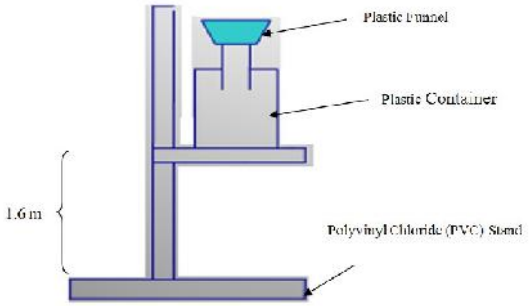

Figure 2. Diagram of locally assembled TAD gauge (Onwudiegwu et al., 2016)

Meteorological Data

The meteorological data used for the study was obtained from Department of Meteorology, School of Earth & Mineral Sciences, Federal University of Technology, Akure, Ondo State, Nigeria.

Statistical Analysis

Minitab 16 Statistical Software was used in the statistical analyses.

RESULTS AND DISCUSSION

The meteorological data (Air temperature, rainfall, wind speed and direction and humidity) in this study are shown in table 1. The average temperatures, wind speed, relative humidity, rainfall and wind direction for the periods was 25.00^{o}C, 0.63mph, 83.74%, 0.03mm and 117.43^{o} (2015) and 26.20^{o}C, 0.74mph, 81.89%, 0.92mm, 118.32^{o} (2016). From the results, it was observed that the rainfall for these periods was scanty, the humidity was relatively high and the wind speed was low. Ideally, TAD in air surfaces could be washed off by rain or blown off by wind (Habitable Planet, accessed 2017). In the comparison of TAD collected in the different environmental conditions depicted that rainfall and winds could not dissolve a considerable proportion of TAD in the air during the seasons. Rainfall or wind had a high kinetic energy that could dissolve or remove many particles in the air. Air pollution is strongly affected by temperature, pressure, and humidity, and other meteorological parameters. An example is when winds transport some pollutants from their sources across national boundaries and even across the oceans. Rain transports atmospheric pollutants to earth. Temperature inversions cause Smog when air near the Earth's surface is colder than air aloft. Also, temperature inversions reduce vertical mixing and trap pollutants near Earth's surface. Stagnation events by low winds are rampant during the dry season and could lead to the accumulation of pollutants over several days. These scenarios were the reasons for the high TAD values obtained. The results of TAD observed in this study, were comparable to those recorded by Onwudiegwu et al. (2016).

The results (5 to 527 µg/m^2) of this study depicted in figure 2, showed that part of the TAD value recorded exceeded the recommended limit (350 µg/m^2). The highest values were observed in the months of November 2015 to February 2016. During these periods there were scanty or no rainfall. The humidity was high, which aided the depositions. Also, higher values could be as a result of strong wind blown from the areas of the construction sites and high traffic density. The

incidence of TAD on the environ had significant effects on the residents due to complaints of low visibility and dust depositions on buildings, vehicles, and crops. In comparison, of this study results with those obtained by Obioh et al. (2013) for Nigerian mega cities, it was observed that the values of the cities like Aba (422 - 926 µg/m^2), Maiduguri (37 - 370 µg/m^2) and Kano (61 - 757 µg/m^2) were far above the results of this study. The reasons for the differences could be attributed to the higher traffic densities of the study areas, again Maiduguri and Kano are closer to Saharan desert, which is closer to dust. Again, the occurrence Harmattan occasioned by the northeast trade winds with dust haze caused dryness and the increase in the erection of buildings and urban growth may contribute to the increased levels TAD in the dry months.

Figure 2 shows the boxplot results of the samples in the periods of study. The Boxplots in this study were used to compare the distributions of PM in the various months and years. The months of July - November 2015 the boxplots were skewed to the right. Only December was symmetrical because the line on the box was close to the center. The whisker lengths were the same. The boxplots of the months of January, April, May, and June were symmetrical, while those of February and March 2016 were skewed to the right. The reason for the skewing to the right was that there were large variations in the values of TAD recorded for the months.

According to Streit and Gehlenborg, (2014), boxplot is known as 'box-and-whiskers plots' in a visual display, boxplot is made up of the minimum, the maximum, the median, the upper quartile, and the lower quartile. The box is rectangular and has the two quartiles (Minimum (lower) and maximum (upper)) at both ends. The length of the box is the interquartile range. At the median, a line is drawn across the box. Boxplots are can be freely drawn in different orientations. The height is the length of the box, which is the indication of sample variability. The place where the sample is centered is depicted with a line across the box.

Table 1. Meteorological data of the study area

Parameters	Average	
	2015 July – December	**2016 January - June**
Air Temperature (^{o}C)	25.00	26.20
Wind Speed (mph)	0.63	0.74
Relative Humidity (%)	83.74	81.89
Rainfall (mm)	0.03	0.92
Wind Direction (^{o})	117.43	118.32

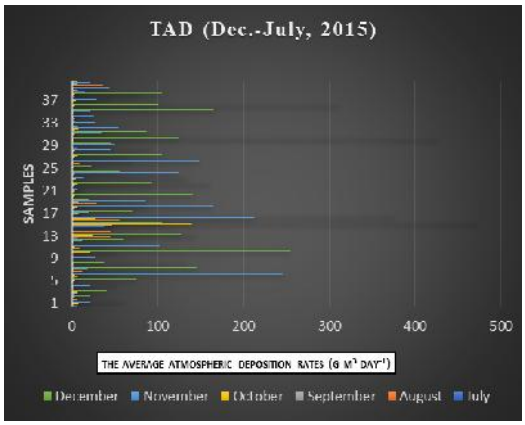

Figure 3. TAD for the months of Dec – July, 2015

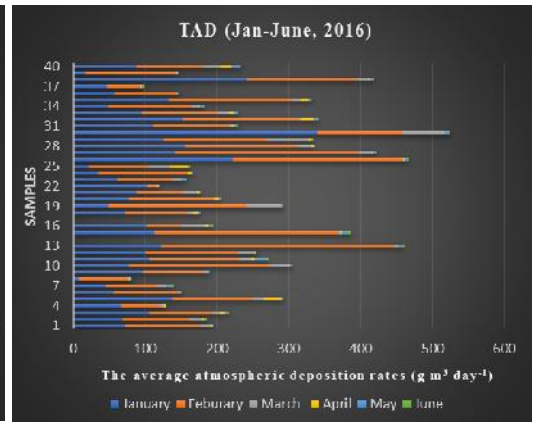

Figure 4. TAD for the months of Jan – June, 2016

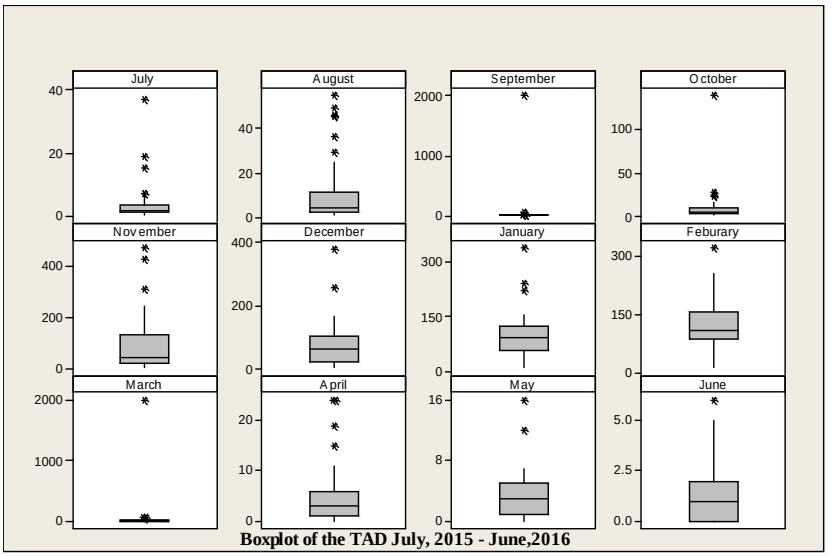

Figure 5. Boxplot of the TAD July, 2015 – June, 2016

CONCLUSION

No doubt some TAD values were high and there were relationships between TAD and meteorological data of the environ. Man-made activities in Akuremay have contributed to TAD. An awareness should be created on the potential danger of air pollution to the citizenry. The results obtained in this study would assist in the clean air programs in the area. Further research is ongoing to determine the metal concentrations in both rainwater and TAD samples obtained in Akure.

Acknowledgment

The authors are grateful to the HOD and Mr. Ladipo of the Department of Meteorology, School of Earth & Mineral Sciences, Federal University of Technology, Akure, Ondo State, Nigeria for the provision of meteorological data.

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EVALUATING URBAN SPRAWL AND LAND-USE CHANGE USING REMOTE SENSING, GIS TECHNIQUES AND HISTORICAL MAPS. CASE STUDY: THE CITY OF DEJ, ROMANIA

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Abstract: The aim of this paper is to analyse, using GIS and remote sensing techniques, the land use/cover change of the city of Dej, in order to explore the spatial and temporal characteristics and the consequences of urbanization trends of the past 250 years. We used a wide range of data, including historical maps and Landsat images from 1984 to 2017. In order to identify the land-use change, we used supervised classification and change detection methods. Analysing the obtained data, we could conclude the fact that, between 1763 and 1990, the area was characterized by a significant urban sprawl and land-use change, due to the economic development and political views (the urban border area increased from 1.2 km2 to 13.72 km2), but after 1990, the suburbanization process has begun, due to the economic failure, having a 13.85% built-up area increase towards S-SE and N direction, constrained by hydrological and geomorphological factors.

Key words: remote sensing, land-use and cover change, change detection, GIS, satellite imagery, historical maps

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INTRODUCTION

Remote sensing data covers large areas and it's characterized by a high temporal and spatial frequency; remote sensing can provide historical time series data; therefore, it became widely used with success in monitoring urban sprawl and land-use cover changes (Xiao et al., 2006; Stefanov et al., 2001). Landscape dynamics is an important issue in remote sensing and digital change detection, and can be analysed by using multi-temporal and multi-spectral satellite imagery (Rawat and Kumar, 2015). By land-use change, we mean a process by which anthropic factors transform

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the natural landscape; they are usually non-linear and can threaten people with vulnerability (Kasperson et al., 2017). According to Lakshmana, 1993, land-use is the result of an accumulation of individual decisions, in order to satisfy some objectives within some set of land-use constraints or attractions; moreover, the growth of the land can also depend on the historical development, importance and attraction of the investigated area. Mapping land-use/cover change at local/regional scales can be used for different applications, like land planning strategies or hazard mitigation works (Reis, 2008).

To understand the consequences of the environmental changes, we need to use up-to-date and accurate data (Giri et al., 2005; Shalaby and Tateishi, 2007). With remote sensing techniques, the monitoring of these changes becomes possible. In order to extract change information from satellite data, we need to use effective and automated change detection techniques (Roy et al., 2002; Shalaby and Tateishi, 2007). By integrating remote sensing with GIS techniques, it becomes possible to analyze and classify different patterns during a long period of time, to efficiently exploit factors that cause land-use change and to understand the evolution trends of the urban area (Fichera et al., 2017). The urbanization is an inevitable and a widespread process, due to economic development and rapid population growth, which causes loss land-use and cover change, as it follows: loss of forest areas and arable lands, vegetation cover decline, built-up area expansion. (Lopez et al., 2001; Shalaby and Tateishi, 2007; Dewan and Yamaguchi, 2009).

There are various publications regarding the change analysis of urban areas: Chowdhury, 2003; Fang et al., 2005; Yuan et al., 2005; Gatrell and Jensen, 2008; My et al., 2009; El Garouani et al., 2017. These studies are important, because they promote a sustainable urbanization and they also illustrate the interaction between people and urban environments in which they live (Gatrell and Jensen, 2008).

In remote sensing, a variety of techniques have been developed in order classify different landscape components (Ozesmi and Bauer, 2002): unsupervised classification, supervised classification, PCA (Principal Component Analysis), Fuzzy Classification (Lu et al., 2004; Butt et al., 2015). The most widespread types of classifications are the following: supervised classification, PCA and Fuzzy Classification (Butt et al., 2015). Also, there are many change detection methods, from which the pre- and post-classification method was widely used (Dewan and Yamaguchi, 2009).

Therefore, the aim of this study is to evaluate, using remote sensing and GIS techniques, the land cover/use change and urban sprawl of the city of Dej, Romania, between 1763 and 2017, using multi-temporal satellite imagery and historical maps (The Military Surveys of Austrian Empire, The 1st, 2nd and 3rd Military Mapping Survey of Austria-Hungary; different Romanian historical maps, between 1916-1959 – "Plan Director de Tragere"; sources: mapire.hu; geo-spatial.org). We selected the study area for analysis, because of its particular historical, geomorphological and hydrographical characteristics: active water erosion, land instability phenomenon and water level fluctuations, social and economic changes, especially after 1990, therefore, we could observe how these constraining factors affected the evolution of the city of Dej for approximately 250 years.

STUDY AREA

The study area, the municipality of Dej, has a population of 33 497 citizens according to the 2011 census and has a surface of 109 km^2.

From a geographical point of view, the city is situated within the central part of Transylvania, at the confluence of the Someșul Mic and Someșul Mare Rivers (figure 1), also being situated at the intersection between the 47°05′12″N parallel and the 23°48′19″E meridian, at 57 km away from Cluj-Napoca.

The city of Dej, from a geological and geomorphological point of view, is distinguished by large terraces, massive hills, with a wide range of land instability phenomenon and a highly developed hydrographic network, characterized by linear and vertical erosions (Ilovan and Papp, 2007). The city is located in a depressional area of water clusters, where Someșul Mic, Someșul

Mare, Valea Codrului, Valea Olpretului, Valea Ungurașului, Valea Ocnei, Valea Chiejdului Rivers meet, resulting a flattened meadow, prone to floods and water level fluctuations (Plan Urbanistic General al Municipiului Dej, Memoriu General, 2005). Therefore, this area became very active in terms of erosional processes, eutrophication and sedimentation. These characteristics contributed, mostly to the modification of land-use structure and spatial evolution of the city.

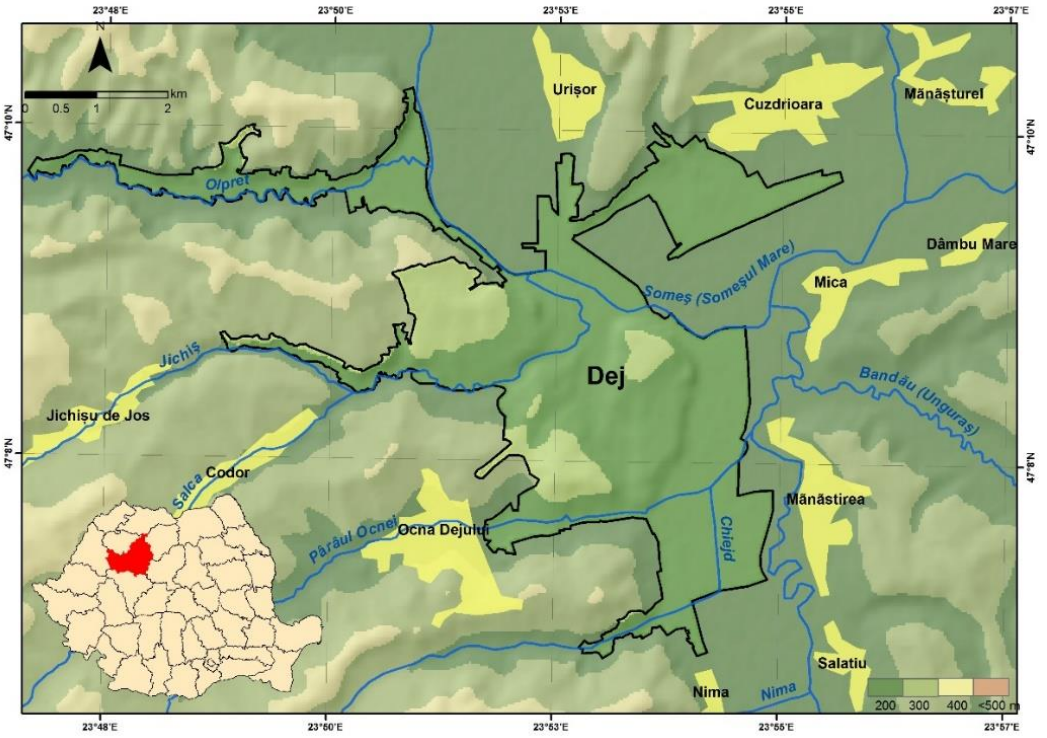

Figure 1. The geographic position of the city of Dej

The severity of many floods determined the deviation and drainage of some of the Someș River arms. After the damage of the 1970 floods, the urban planning strategy of the city was reorganized and a new and higher embankment was constructed near the river bed.

SPATIAL DATABASE AND METHODOLOGY

In order to realise land-use change and urban sprawl analysis, the acquired data must be adequate and precise. The spatial database contains cloud-free satellite imagery (Landsat 5 MSS, Landsat 7 TM, Landsat 8 OLI), historical maps and vector shapes (mapire.hu, geo-spatial.org) (table 1).

In order to emphasize the structure of the land use, we used multi-temporal imagery from different periods of time (Landsat 5 from 1984 July, Landsat 7 TM from 1993 July, Landsat 8 OLI from 2017 July).

This imagery was pre- and post-processed using ERDAS 2014 software. Geometric corrections were applied on all the satellite imagery of the Dej city area. The resolution of the satellite images is 30 m.

The four historical maps were georeferenced and digitized using ArcMap 10.6 (figure 2). The maps were converted into Stereographic 1970 projection. While digitizing the maps and

satellite imagery, we created the following shape files: urban area borders, hydrography, forests. These shape files were used to calculate statistics in different periods, so we could determine the rate of urban sprawl and the effects of this process on the environment.

Table 1. Spațial database

Name	Type	Source
The 1st Mapping Survey of Austria-Hungary 1763-1787	Raster and vectorized	mapire.eu
The 2nd Military Mapping Survey of Austria-Hungary 1806-1869	Raster and vectorized	mapire.eu
The 3rd Military Mapping Survey of Austria-Hungary 1869-1887	Raster and vectorized	mapire.eu
„Planurile Directoare de Tragere" 1916- 1959	Raster and vectorized	mapire.eu
Landsat 5, Landsat 7, Landsat 8 (1984, 1993, 2017)	Raster and vectorized	USGS

Using historical maps to extract information and data form the pre-satellite ages is relatively simple, even though, there could exist some accuracy errors, because the maps were digitized on different accuracy-levels, but the influence of this variability minimal because of the coarse time scales used in the present (Xiao et al., 2006).

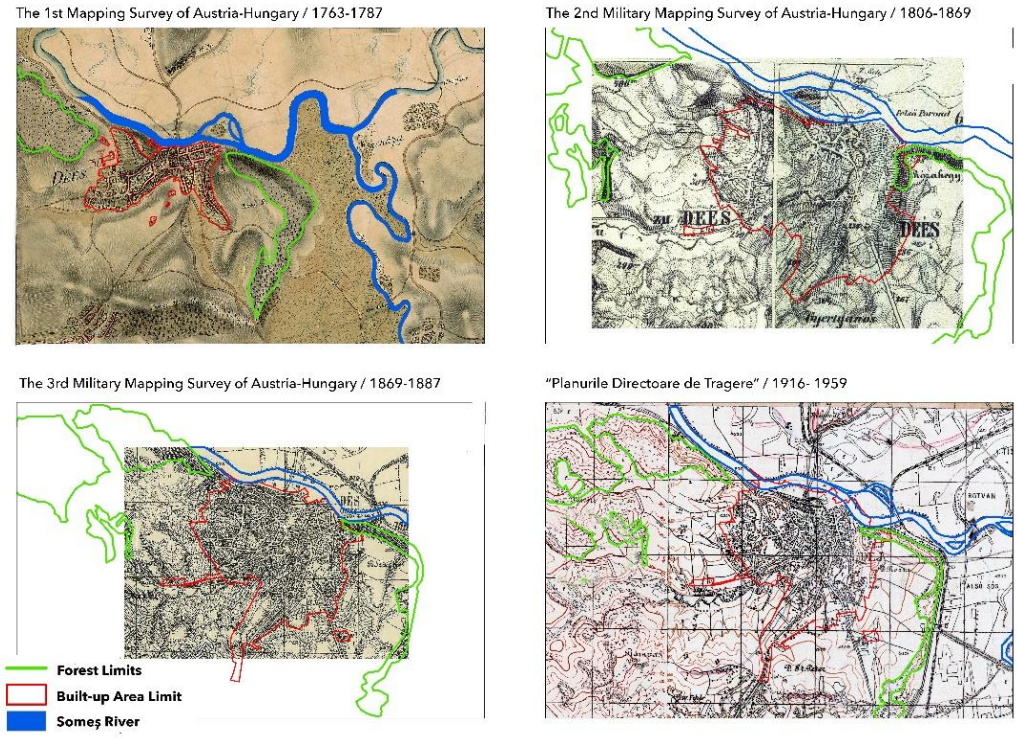

Figure 2. The georeferenced historical maps

Image pre-processing

The most important step is the image pre-processing, in order to realize an adequate change detection. In this study, we used geometric corrections and image enhancement.

Geometric registration is required to remove random distortions (variation in sensor system attitude and altitude) present in remote sensing data (Rogan and Chen, 2004). The Landsat images were geometrically corrected, obtaining a < 0.5 pixel route main square error (RMSE). The RMSE between any two dates must be less than 0.5 pixel to become an acceptable error (Lunetta and Elvidge, 1998; Shalaby and Tateishi, 2007). Post classification

method does not require radiometrical or normalized corrections before the images are used for change detection (Warner and Campagna, 2009).

Image enhancement is a process in which we can change the pixel values in order to emphasize the information within an image, and to increase the apparent distinction between different features (Abd El-Kawy et al., 2011). In this study, we used contrast stretching in order to visually analyze different features (Abd El-Kawy et al., 2011). Some classes can be spectrally confused and they cannot be separated by supervised classification, therefore, it becomes necessary visual interpretation (Shalaby and Tateishi, 2007).

Image classification

We applied the maximum likelihood supervised classification on the satellite images (Landsat 5, 1984; Landsat 7, 1993; Landsat 8, 2017 (figure 3) using training samples. The objective of the image classification is to automatically categorize within an image into land cover classes (Lillesand and Kiefer, 1994; Shalaby and Tateishi, 2007). The area was classified into four land-use categories: arable land, vegetation, hydrography and built-up area.

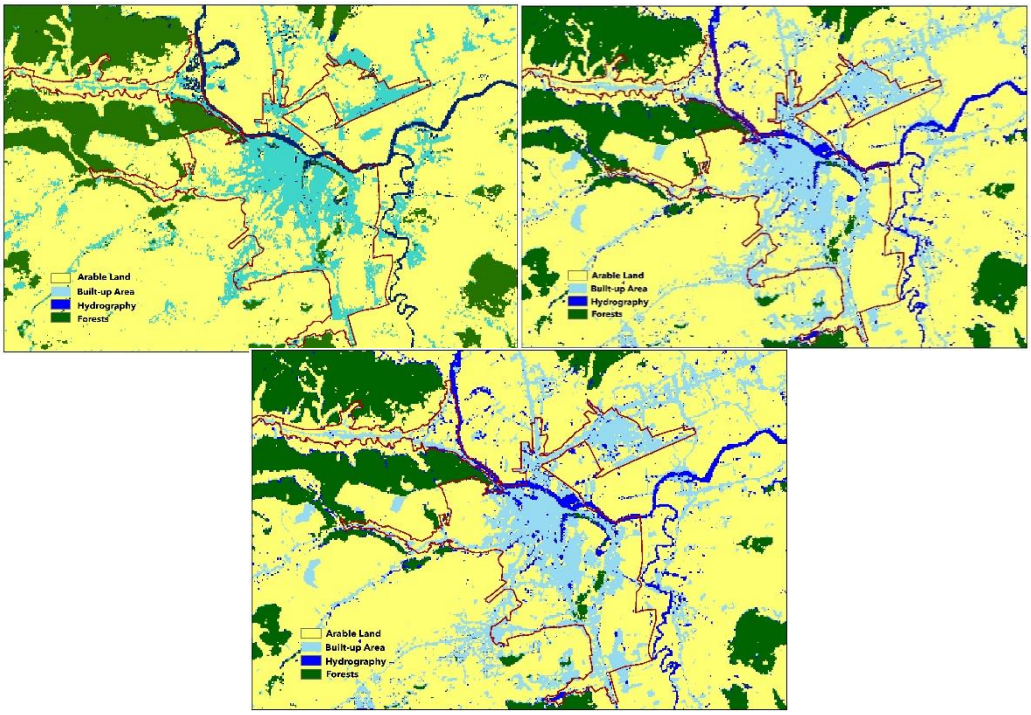

Figure 3. The classified Landsat images
(left: Landsat 5, 1984; right: Landsat 7, 1993; middle: Landsat 8, 2017)

An accuracy assessment was applied on the classified images. It is important to perform accuracy assessment for individual classification in order to verify if the results are useful (Owojori and Xie, 2005). The classification accuracy assessment was realised by generating an error (confusion) matrix, which implies the calculation of the overall accuracy (representing a ratio between the total number of correctly classified and the total number of reference pixels) and Kappa coefficient (Cohen, 1960; Liu et al., 2007; Olofsson et al., 2014). The Kappa coefficient, evaluates the level of agreement between the observed and predicted classes; the value of the coefficient varies between 0 and 1 (Hogland et al., 2013; Foody, 2002).

The Kappa coefficient was calculated based on the equation:

$$k = \frac{N\sum_{i=1}^{r} x_{ii} - \sum_{i=1}^{r} (x_{i+} x_{+i})}{N^2 - \sum_{i=1}^{r} (x_{i+} x_{+i})}$$

where:
N = the total number of observations (pixels) in the confusion matrix;
r = the number of rows in the confusion matrix;
Xii= the number of observations (pixels) in the i row and i column;
Xi+ = marginal sum of observations (pixels) of row i;
X+i = marginal sum of observations (pixels) of column i

Change detection

Change detection was applied using the post-classification method between 1984-1993, 1993-2017, based on the satellite imagery presented above.

The post-classification technique provides ‘‘from–to’’ change information, therefore, any landscape transformation can be easily observed and mapped (Yuan et al., 2005). This method allows to determinate the difference between independently classified images and it is the only method that allows the calculus of every pixel-change (Fichera et al., 2017). In order to realise the change detection analysis, we used the cross-tabulation method (Tabulate area tool in ArcGIS 10.6).

RESULTS

Before realising the analyses, we tested the validity of the classified images, using the Kappa coefficient presented above. The values of the Kappa coefficient, according to Congalton, 1991, can be divided into 3 groups: values higher than 0.80 means strong agreement between the classified data and reference data; values between 0.40-0.80 represent a moderate agreement; values below 0.40 depict a weak agreement.

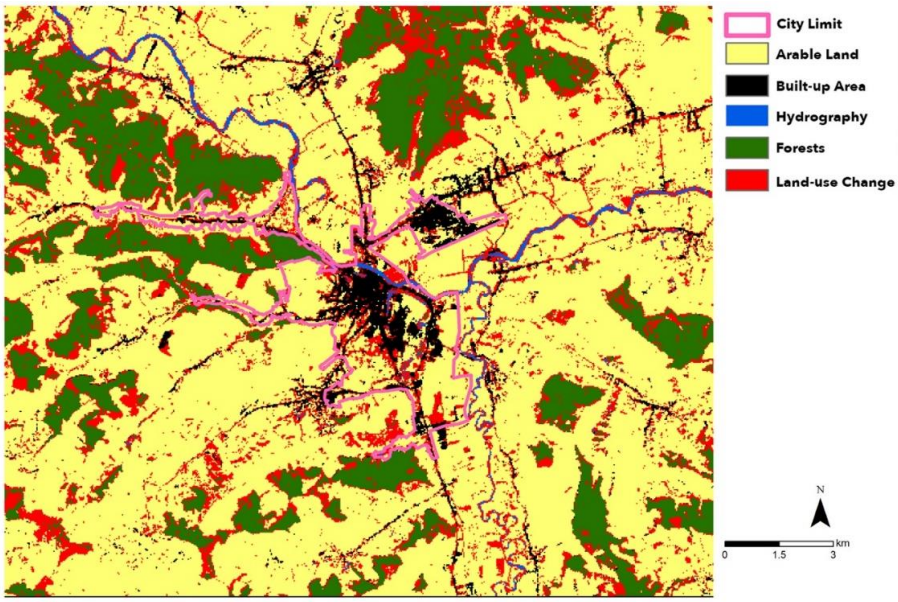

Figure 4. Change detection results (1984-2017)

The accuracy assessments of the 1984, 1993 and 2017 classified images were realised generating 250 random points from each image, having the following results: 0,801 (1983), 0,823 (1993) and 0,890 (2017). These results represent a high agreement between the classified and reference data, therefore, we could made further analyses.

The results of the change detection analysis can be observed on figure 4. With the help of the cross-tabulation tool, we could clearly calculate the growth of the built-up area by 13.85% (many new constructions appeared between 1984 and 2017).

We could also observe that, between 1984-2017, a slight decrease in vegetation (4.66%), and we could remark the modification of wetlands and hydrography (a decrease of 4.17% caused by river draining and the river bed modification) (table 2, figure 5).

Table 2. The modification of the land-use in percentage between 1984 and 2017

Land-use type	1984 (%)	1993 (%)	2017 (%)
Water and Wetlands	6.060056	2.271632	1.894316
Arable land	66.28411	65.85477	61.27400
Built-up Area	8.237745	13.87883	22.09671
Vegetation	19.418089	17.99415	14.75532

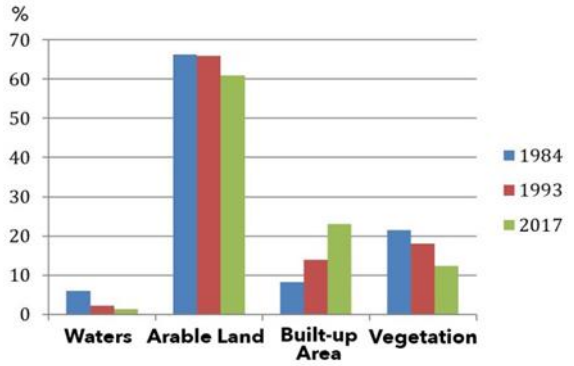

Figure 5. The land-use change tendency between 1984 and 2017

To explain the results of the change detection, we analysed the satellite imageries and the historical maps from the past 250 years. We observed the fact that, the city of Dej is characterized by some high and low stages.

When comparing the historical maps and the satellite imageries, we concluded the fact that, the urban border area was modified gradually between 1763 and 1984, increasing from 1.2 km^2 to 13.72 km^2 (table 3). This increase is due to the following facts:

a) In the 18th century, the city of Dej, due to its particular position (salt resources near the surface; economic potential; intersection of three river corridors) became favourable to the appearance of communication crossroads; these factors ensured the development of a market town (Ilovan and Papp, 2017; Rüsz, 2003). This increase can be observed on the 1st and 2nd Mapping Survey of Austria-Hungary; the urban border area has increased by 116.66% (figure 6, table 4) and the forest lands decreased by 47.29% (table 4).

b) In 1881, the railway infrastructure was set up, therefore, Dej became an important railway connection knot between the northeast, northwest, and the south of Transylvania, hence it helped the economic development of the city (Ilovan and Papp, 2007). This modification can be observed on the 3rd Military Mapping Survey of Austria-Hungary by the increase of the urban border surface with 20.76% (figure 6, table 4).

c) After the Second World War, new food units, wood- and raw material processing industries appeared, therefore, increasing the attraction of the city (many people from nearby

villages migrated in Dej due to the communist regime) (Ilovan and Papp, 2007). As a consequence, the urban border area has increased significantly by 281.11%, and the forest lands had decreased dramatically by 82.05% (figure 7, table 4).

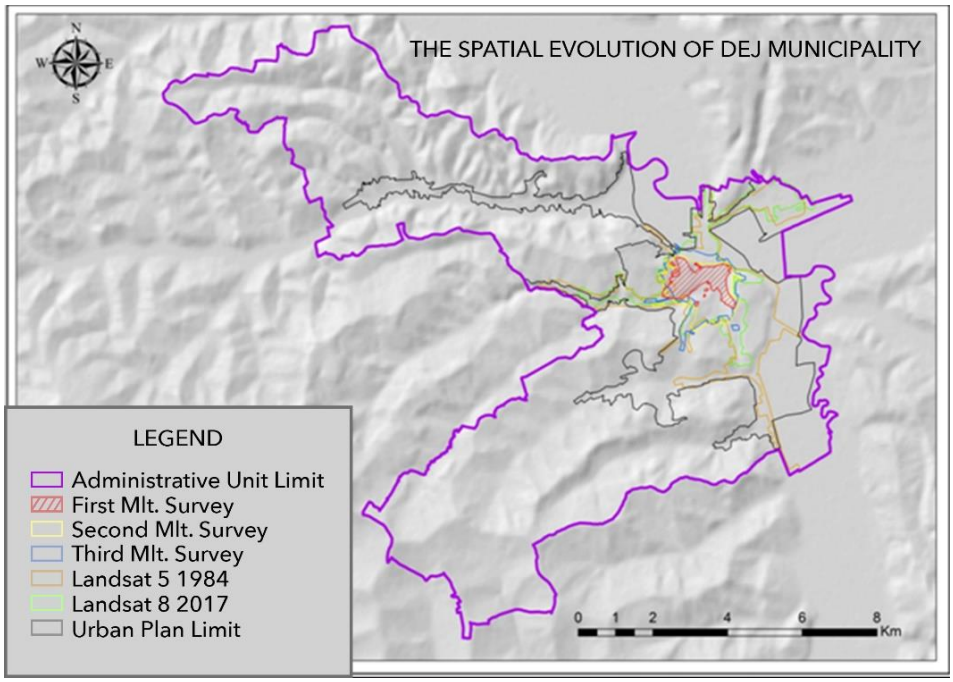

Figure 6. The urban-border area increase over 250 years

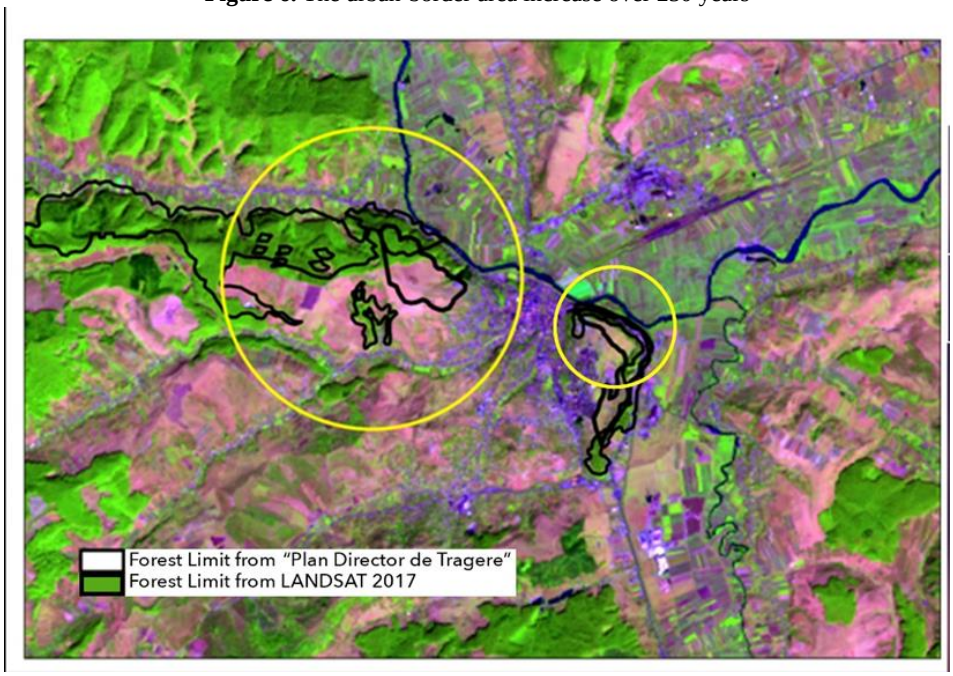

Figure 7. The dramatic decrease of forests

After 1990, the suburbanization process of the city was emphasized using supervised classification and the post-classification method, the built-up area increased by 13,85% towards S-SE and N communication roads, near the city limit; the urban border surface has increased by 49.27% due to the new political, social and economic context introduced into the Romanian society; the old industrial units were privatised and were still using old, polluting equipment, therefore, they couldn't sustain the market for selling products, hence having low productivity (Benedek and Bagoly, 2005; Ilovan and Papp, 2007). Due to the higher attraction of other neighbouring spaces (due to the domination of agricultural activities and industries), like Cuzdrioara, Căşeiu, and Jichişu de Jos and Mica, the suburbanization process of Dej city has begun (Ilovan and Papp, 2007). In this period, due to a low industrial profile, the forest areas were represented by stagnation (table 3).

Table 3. The surface modification of the urban border's area and forests between 1763 and 2017

Land-use type	The 1st Mapping Survey of 1763-1787	The 2nd Mapping Survey of 1806-1869	The 3rd Military Mapping Survey of 1869-1887	"Plan Director de Tragere"	Landsat 5 (1984)	Landsat 8 OLI (2017)
Urban border area (km^2)	1.2	2.6	3.14	3.6	13.72	20.48
Forests (km^2)	1.48	0.78	0.78	0.70	0.16	0.14

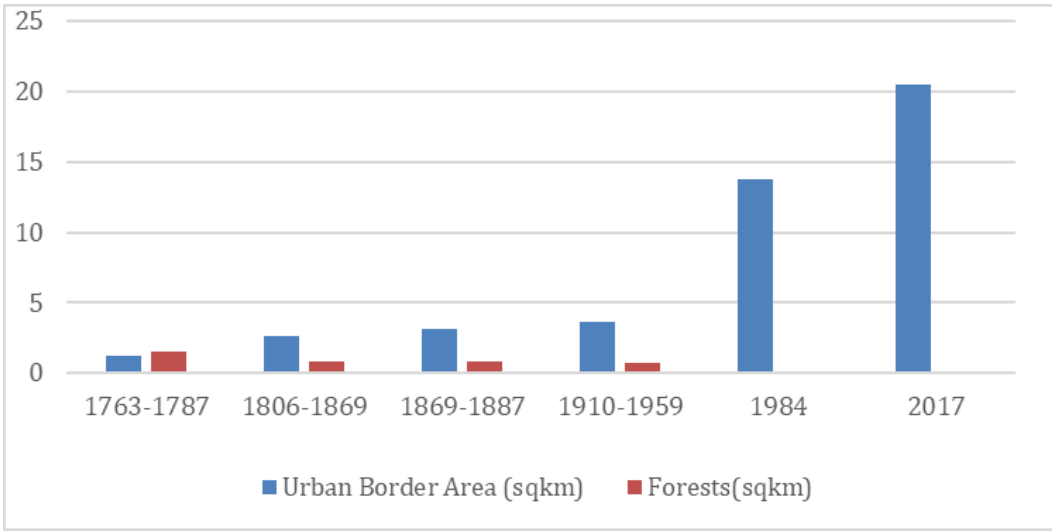

Figure 8. The evolution of the urban border area and of the forest lands between 1963 and 2017

The Someş River bed, due to several floods (which effects can be emphasized on the Military Survey's and on the "Plan Director de Tragere") diverged strongly, therefore, it was necessary to deviate or to drain some of the river arms. This represents an important directing factor of the urban sprawl. Between 1984 - 2017, we could observe a slight modification of the hydrography (a decrease of 4.17% of wetlands based on the change-detection method), due to the reorganized urban strategy of the city. The maximum deviation (1.3km) can be observed by overlaying the 1st Mapping Survey of Austria-Hungary with the Landsat 8 imagery from 2017. Therefore, we can conclude the fact that, this area is a highly dynamic surface from a hydrological point of view.

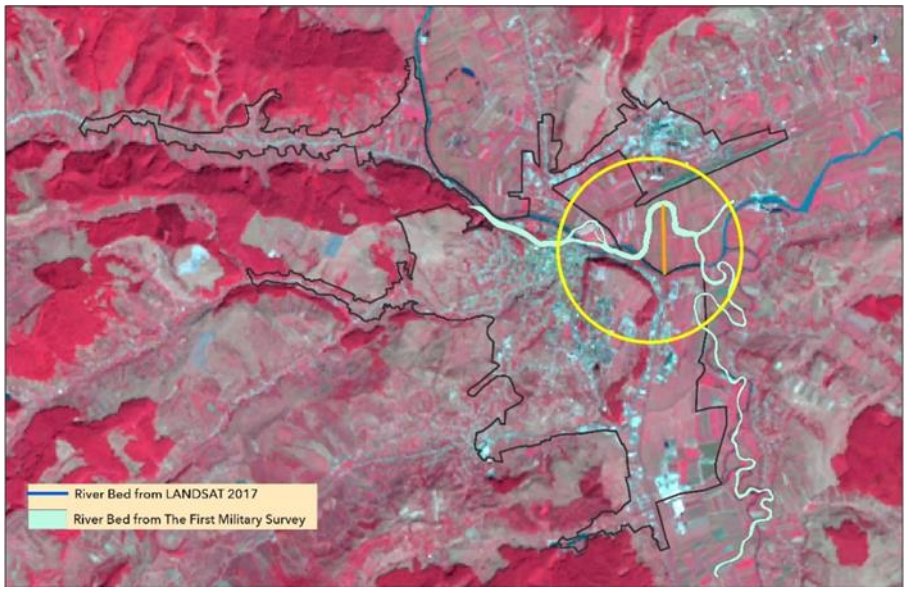

Figure 9. The maximum deviation of the Someș River bed

Observing the suburbanization tendency of the study area, we could calculate, according to Lakshmana, 1995, the future-land growth, by using geometrical weighted parameters, population and distance data of the neighbouring rural spaces. The followings are the formulas and the population and distance values that can be found in table 4 (the values were calculated using ArcGIS 10.5):

Future built-up land area = (*Growth potential x the area of the city in the present + the area of the city in the present*)

Where:

$$\textbf{The growth potential} = \frac{\text{Weighted index potential}}{\text{Influence rate of built-up area}}$$

$$\textbf{Weighted index potential} = \frac{\sum \text{Area of potential x distance between village and city}}{\sum \text{Distance between village and city}}$$

$$\textbf{Influence rate of built-up area} = \frac{\text{Circumference of city}}{\text{Area of city}}$$

Table 4. The neighbouring villages and the distance between them and the city of Dej

Village	Cetan	Urișor	Cuzdrioara	Mica	Codor	Mănăstirea	Ocna Dejului
Distance	7.5km	3km	4.5km	4km	3.8km	4.2km	3km
Surface	0.92km^2	1.88km^2	1.973km^2	0.725km^2	1.35km^2	1.13km^2	2.855km^2

Based on this formula, we calculated the future built-up land area of the city of Dej, which is 30.97 km^2. This value represents an increase by 47%, therefore, we can conclude the fact that, in the future, the villages will unite with the city, as a consequence of the suburbanization process.

DISCUSSIONS AND CONCLUSIONS

Based on the results of this study, we can confirm that, the urbanization process has significantly modified the land-use between the 1763 and 2017 period. We successfully combined GIS and remote sensing techniques in order to calculate the rate and the tendency of land-use change, and the urban sprawl of the investigated area.

With the help of the historical maps, supervised classification and change-detection techniques, we could identify the factors that changed the land-use of the study area: in the 18th century, due to the city's particular setting, Dej became a market town, therefore, the urban border area had grown by 116.66% and the forest lands decreased by 47.29%; in 1881, the railway infrastructure had developed, leading to the development of the city's economy, having, as consequence an increase of 20.76% urban area; after the Second World War, new industries appeared, therefore. population migration had begun and the urban border area has increased significantly by 281.11% and the forest lands had decreased dramatically by 82.05%; after 1990, the suburbanization process of the city has begun, caused by new political, social and economic contexts introduced in Romania; due to the economic loss and the attraction of the rural sites, the built-up area has increased by 13.85% in the S-SE and N direction, near the northern communication roads; the forest lands were characterized by stagnation. Using Lakshmana's formula, we could predict the fact that, in the future, the city of Dej will unite with the neighbouring villages, having a 47% built-up area increase.

The Someș River bed, due to several floods, changed drastically, therefore, it was necessary to deviate and drain some of the river's arms. Due to this fact, the urban sprawl has a south- south-east orientation, bypassing the river bed direction.

The information obtained with remote sensing and GIS techniques are essential in order to understand the causes of land-use change in the city of Dej, and can be used for further land-planning strategies and hazard mitigation works, in order to have a sustainable urban planning. Proper management of land-use is required, because if this does not exist, forest areas can't be restored, and land-degradation will appear due to the over-usage of the arable lands.

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CLIMATE CHANGE INDUCED CHALLENGES ON DEFORESTATION: THE NEEDS TO EDUCE MITIGATION MEASURES IN NIGERIA

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Abstract: Climate change induced challenges and ecologically degrading has been evident in persistent forest depletion in the world. This environmental problem has been in alarming rate most especially in the developing world. With global outcry on the consequences of constant unsustainable forest destruction topping the agenda of most contemporary intellectual discourses in the recent time. Thus, the need to examine the current deforestation situation necessitates a work of this nature. The analysis of challenges facing economic forest in Nigeria and the likely mitigation measures to embark upon in as to reduce the degradation of forest in the country is overdue. The paper establishes the existence of pressures on the forest communities in Nigeria due to number of causes such as; urbanization, overpopulation, mining and agricultural expansion programmers among others. For the nation to retain the forest resources that promote rural welfare, income and employment generation, urban and rural livelihood, poverty alleviation, and sustainable forest management, great attempt needs to be made to guide against human activities that encourage forest depletion. Potential forest degradation crises have made it clear that the environment and the economy can no longer be considered in isolation. At the same time, financial and economic crisis has provided the opportunity for policy interventions aimed at discouraging deforestation of the environment and renewed growth on more environmentally and socially sustainable.

Key words: deforestation, sustainable forest management, climate change

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INTRODUCTION

Actions of mankind's on the environment and in his pursuit for development have resulted in a serious degradation of the ecosystem, thus pose a threat to the present and future generation. All human beings are attached to use the environment in three basic ways: as a resource bank - the

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environment supplies them with raw materials needed to maintain their existence, and their social and technological structures; as a habitat - people require more space per individual than any other species, and as sink for wastes- human beings produce more waste than other species (Ogundele and Oladipo, 2016). [1] Deforestation has created one of the global development challenges, in particular, it is the most serious long term environmental problem facing the world and Nigeria is not an exception. Historically, the overzealous for all round development in Nigeria at the attainment of independence in 1960, was seen on rapid growth from a predominantly primary production based economy to an industrialized economy with strong inter-sectoral linkages. The optimism regarding the possibility of a significant progress towards attaining self-sustained and rapid industrialized development within a generation or two was heightened by the emergence of the unprecedented large foreign exchange earnings from crude oil. But after over four decades, this dream has remained largely unfulfilled in spite of all the development initiatives adopted. Adebayo (2010) opined that poor living conditions and illiteracy are causes as well as consequences of environmental degradation. The high level of poverty and illiteracy in Africa directly linked to the current level of environmental pollution and degradation in the continent. The poor and the illiterate are often more interested in issues related to their daily survival than environmental management; this lack of interest and awareness often lead to more reckless environmental behaviour which in turn breeds more environmental problems and leads to a vicious cycle of poverty. [2]

Nigeria lies between latitude and longitude of 10º North and 8º East. The location of major forests in Nigeria could be found in the Swamp forests, the Tropical Rainforests, and the Wooded Savannah in the southern axis of the country. The total land mass of Nigeria is about 910,770 km^2 and among these, the total forest area covers about 110, 890 km^2 this representing about 12.18% of the total forest cover of the country. There are about 1417 known species of amphibians, birds, mammals and reptiles in the country (UNEP, 2004; Mfon et al., 2014). The forests are dominated by canopy trees with complex ecological system and the crowns of these trees intertwined as a result of their close-nit growth. Most of trees are perennial woody plants usually with stems which support branches and leaves. The height of some of these trees ranges from 8 meters to over 100 meters above sea level. Within the forests there are series of economic herbs, shrubs, climbers, lianas and other valuable plant species as well as mixed flora and fauna. Also, within the forest floor are litter and soil microbes which render forest soils fertile for tropical farming (Mfon et al., 2014).

Nigeria is naturally gifted with large extent of forest land with the swamp forests located in the extreme Southern part of the country with the tropical rainforest in the Southwestern fringe, while the wooded Savannah is glamorously found in the Middle-belt area of the country. Nigeria ranks among developing countries of the world with abundant forest resources, with about 60 percent of all known species of plant, 90 percent of all the world's non-human primates such as monkeys, and about 40 percent of all the birds of prey and about 80 percent of all the insects live in the tropical rainforests of the world (Park, 1992).

According to European Forestry Commission (2010), the world continues to lose some 15 million hectares of forests every year. Deforestation over the period 1980 to 1990 reached 8.3% of total forest area in Asia, 6.1% in Latin America and 4.8% in African. Most modern deforestation emerges in developing countries, particularly in tropical areas. Deforestation and forest degradation caused by climate change indirectly or directly threaten as many 400 million people including 50 million forest indigenous people who depend on forest for subsistence in sub-Sahara Africa (EFC, 2010). Deforestation estimates for some African countries as described by Lanly (1983) that the of forest depletion in Cote divoire and Nigeria is estimated as high as 5 to 6% per year while Ochanda and Epp (1982) stated that in Kenya the indigenous forest now covers only 1.9% and about 16% of the forest is being lost in each ten year period.

[1] *http://en.wikipedia.org./wiki/deforestation*
[2] *http://en.wikipedia.org/wiki/Millennium*

Back home in Nigeria, the UNFAO ranked Nigeria in 2013 as having the highest rate of deforestation in the world (Aikhiombar, 2015). The regional breakdown of deforestation in Nigeria from 1979 to 1995 shows that total forest declined by 48% in the North-central 7% in the North East, 60% in the North West, 53% in the south East, 13% in the South-South and 12% in the South West (FORMECU, 1996). In 2000 the forest cover was estimated at 13.5 million hectares compared to 17.5 million hectares in 1990 (FAO, 2001), indicating a forest cover loss of close to 400 thousand ha per annum, or a decline of about 2.6%. Forest/woodlands now stand at only 13% of the total land area (FAO, 2001). Hence, global observation on the challenges and consequences of continuous unsustainable forest destruction topping major intellectual agenda. This paper therefore focuses attention to global outcry on evil of deforestation status and tries to evaluate the urgent need for rigid mitigation measures to alleviate the impacts of climate induced challenges on deforestation in the tropical world including Nigeria.

CONCEPTUAL ISSUES OF DEFORESTATION

Deforestation refers to the felling, cutting and clearing of forest cover or vegetation includes tree plantations in order to pave way to agricultural, industrial, urban or rural land use. In other words, it involves termination of forest cover to make land available for residential, commercial and industrial purpose or both. Conversely, the removal of trees without sufficient replacement is always leading to reduction in habitat, wood, biodiversity, and quality of life in an ecological community. The term "Deforestation" is associated with modification of forestry layout such as; felling of wood for fuel, commercial logging and activities associated with temporary removal of forest cover such as slash and burn technique, all which is a major component of shifting cultivation agricultural systems. [3] It is equally used to describe clearing of forest for grazing or temporary ranching. By and again, it is also involved the establishment of industrial plantations which may be considered as deforestation by some people while others may view it as afforestation. The consequences of deforestation are so massive and astonished, in that between 1990 and 2005, Nigeria has lost about 79% of her old-growth forests (Rainforest Mangabay, 2007).

Over the last century the forest cover around the globe has been greatly compromised, leaving the green cover down to lower ebb of about 30 per cent. According to the United Nations Food and Agriculture Organization (FAO), an estimated 18 million acres (7.3 million hectares) of forest are lost each year around the world (Mfon et al., 2014).

Many countries in the developing world have been noted with the largest net loss of forests per year within 2000-2010, this was reduced to six million hectares per year as a result of reductions in Indonesia, Sudan, Brazil and Australia (see table 1). There were 28 countries and areas which have an estimated net loss of one per cent or more of their forest area per year. The five countries with the largest annual net loss for 2000-2010 were Comoros (-9.3 per cent), Togo (-5.1 per cent), Nigeria (-3.7 per cent), Mauritania (-2.7 per cent) and Uganda (-2.6 per cent). The area of other wooded land globally decreased by about 3.1 million hectares per year during 1990-2000 and by about 1.9 million hectares per year during the last decade. The area of other wooded land also decreased during the past two decades in Africa, Asia and South America. Country Annual change 1990-2000 Country Annual change 1990-2000 1 000 ha/year % 1 000 ha/year % Brazil -2890 -0.51 Brazil -2642 -0.49 Indonesia -1914 -1.75 Australia -562 -0.37 Sudan -589 -0.80 Indonesia -498 -0.51 Myanmar -435 -1.17 Nigeria -410 -3.67 Nigeria -410 -2.68 Tanzania -403 -1.13 Tanzania -403 -1.02 Zimbabwe -327 -1.88 Mexico -354 -0.52 the Congo -311 -0.20 Zimbabwe -327 -1.58 Myanmar -310 -0.93 Congo -311 -0.20 Bolivia -290 -0.49 Argentina -293 -0.88 Venezuela -288 -0.60 Total -7926 -0.71 Total -6040 -0.53 (see table 2). Countries with largest annual net loss of forest area, 1990-2010 (Anonymous, 2010).

[3] *http://en.wikipedia.org./wiki/deforestation*

Table 1. Annual change in forest area in Africa, Asia and Europe region and sub-region, 1990-2010
Source: Anonymous, 2010, as modified by the Authors

Region/sub-region	1990-2000		2000-2010	
	1 000 ha/year	%	1 000 ha/year	%
Eastern and Southern Africa	-1841	-0.62	-1839	-0.66
Northern Africa	-590	-0.72	-41	-0.05
Western and Central Africa	-1637	-0.46	-1535	-0.46
Total Africa	-4067	-0.56	-3414	0.49
East Asia	1762	0.81	2781	1.16
South and Southeast Asia	-2428	-0.77	-677	-0.23
Western and Central Asia	72	0.17	131	0.31
Total Asia	-595	-0.10	2235	0.39
Russian Federation (RF)	32	n.s	-18	n.s.
Europe excluding RF	845	0.46	694	0.36
Total Europe	877	0.09	676	0.07

THEORETICAL ISSUES OF DEFORESTATION

Deforestation is one of the important issues in our global climate change age-long discussions. Forest resources can provide long-term national economic benefits. For example, at least 145 countries of the world are currently involved in wood production (Anonymous, 1994). However, sufficient evidence is available that the whole world is facing an environmental crisis on account of heavy deforestation (Andronache et al., 2019; Foley et al., 2005; Pintilii et al., 2017; Sumit et al., 2012). The issues lead to two important environmental challenges such as; loss of biodiversity and increasing of greenhouse gas emission. Many efforts have been introduced, developed and implemented. However, a declining forest cover still persists. Since deforestation is a complex and intertwined issue, understanding its complexity and context on which it is debated is fundamental. There are three major schools of thought associated with the causes of deforestation. The first is the Impoverishment School of Thought (IST) which is of the opinion that, the major cause of deforestation is the increase in the number of poor people; that is, small holders are the principal agents of deforestation. The second school thought is the Neoclassical Group School (NGS) which believes that, deforestation is caused by open access property rights. That is, there are various agents with respect to deforestation. The third school is the Political-Ecology Group (PEG) which believes that, deforestation is caused by capitalist entrepreneurs. [4]

Deforestation could have influence on climate within local or at global degrees through changes in the energy, mass and momentum fluxes between climate subsystems energy reservoirs. Deforestation is also associated with CO_2 emissions, as crops and marginal lands that usually replace trees after land clearing tend to hold less carbon per unit area than forests (Bala et al., 2007). The radiative forcing associated with an increase in atmospheric CO_2 is, from a climatic perspective, the most important biogeochemical impact of deforestation. Increases in CO_2 also have the potential to affect climate by altering transpiration rates, due to CO_2 increased water use efficiency reducing stomatal conductance and increasing plant growth (Friedlingstein et al., 1999; Larcher, 2001).The biogeophysical impacts of deforestation most pertinent to climate infusion are changes to surface albedo, evapotranspiration (ET) and surface roughness length (Bounoua et al., 2002). Croplands and pastures tend to have higher albedo than forests, which causes them to absorb a smaller fraction of the incoming solar radiation. Trees tend to have deeper rooting depth than crops and grasses such that tree removal implies a decreased ET and associated reduction in latent heat flux (Bala et al., 2007; Kliedon, 2000). ET can also be reduced through the reduction in canopy capture following deforestation, as well as from reduced turbulence associated with a lower aerodynamic roughness length and colder temperatures. For large-scale land cover change the alterations in ET could influence cloud formation potentially impacting atmospheric albedo and atmospheric long wave absorption (Bala et al., 2007).

[4] *http://en.wikipedia.org/wiki/deforestation.*

DEFORESTATION AND CLIMATE INDUCED CHALLENGES SYNOPSIS

The removal of trees without sufficient aforestation could lead to reduction in ecological inhabitants, biodiversity as well as wood and quality of life; this could be referred to as deforestation. The use of the term "Deforestation" at times is connected with alteration of forestry issues. It is used to denote activities that use the forest, for instance, felling of wood for fuel, commercial logging and activities associated with temporary removal of forest cover such as slash and burn technique, which is a major component of shifting cultivation agricultural systems or clear cutting. It is equally used to describe clearing of forest for grazing or ranching. Also, an activity such as the establishment of industrial plantations may be considered as deforestation by some people while others will view it as afforestation. The consequences of deforestation are so massive, that between 1990 and 2005, Nigeria has lost a staggering 79% of its old-growth forests (Rainforests Mangabay, 2007).

Over the last century the forest cover around the globe has been greatly compromise, leaving the green cover down to lower ebb of about 30 per cent. According to the United Nations Food and Agriculture Organization (FAO), an estimated 18 million acres (7.3 million hectares) of forest are lost each year (Mfon et al., 2014).

CLIMATE INDUCED CHALLENGES ON FORESTS

Forests are vital to our Earth. About 60 million humans are indigenous who are completely dependent on native woods. Trees purify our air, filter our water, prevent erosion, and act as a buffer against climate change. Trees also offer a home to plant and animal species, while they providing natural resources such as medicine, food, timber, and fuel to about 300 million people who live in forests worldwide. But where trees provision is contrary, climate acts and induces various challenges (Habitat, 2017).

Not long ago, scientists have reached a consensus on the existence of climate change, even though the exact scope of this phenomenon remains somewhat uncertain. In 2007, the International Panel on Climate Change (IPCC) concluded in its Fourth Assessment Report (FAR) that warming of the climate system is unequivocal. During the twentieth century, the average global temperature increased by 0.76 ºC, and it is expected to increase further by 1.8 ºC to 4 ºC during the twenty-first century. Consequently, sea levels rose by 17 centimeters during the last century, rising at a rate of 3.1 millimeters per year between 1993 and 2003. The extent to which sea levels are going to rise during the twenty-first century remains uncertain (Magrin et al., 2007). Though not taking into account ice sheet reaction, the IPCC forecast a further rise, between 18 and 59 centimeters, by the end of the century. In the recent time, the "Copenhagen Diagnosis" concluded that the "global sea level is likely to rise at least twice as much as projected." Beyond global warming and sea level rise, climate change is highly likely to result in more frequent and more severe weather phenomena, such as droughts, heavy rainfall, intense heat, and tropical storms (McCarthy et al., 2007). Undoubtedly, the climate change is as a result of human activity, in particular the emission of greenhouse gases (Walker and Sydneysmith, 2007). Although human beings are responsible for climate change, they also suffer from its diverse consequences. Economic activities, such as agriculture, forestry, and fishery, may be locally impeded (Betts, 2000). Human life and health are also affected due to extreme heat, natural disasters, and a resurgence of certain diseases such as malaria, which together are estimated to cause over 140,000 excess deaths annually world over. One of the most dramatic human consequences resulting from climate induced challenges due to global warming have unique impacts on human settlements. Climate change is degrading the conditions of life in many inhabited territories, sometimes forcing people to move.

Deforestation can impact climate on local and global scales by changes in the energy, mass and momentum fluxes between climate subsystems energy reservoirs.[5] Deforestation is also associated with CO_2 emissions, as crops and marginal lands that usually replace trees after land

[5] *http://en.wikipedia.org/wiki/Millennium*

clearing tend to hold less carbon per unit area than forests (Betts, 2000; Bala et al., 2007). The radiative forcing associated with an increase in atmospheric CO_2 is, from a climatic perspective, the most important biogeochemical impact of deforestation. Increases in CO_2 also have the potential to affect climate by altering transpiration rates, due to CO_2 increased water use efficiency reducing stomatal conductance and increasing plant growth (Larcher, 2001).

CAUSES OF DEFORESTATION IN NIGERIA

Climatic induced challenges

This cause can be divided into three major broad groups: Climatic agents, Biotic agents, and Man/Animals.

a) The climate agents in common, represent the average weather conditions of the country over a long period of about 50 years. They include sunlight, water and wind. Sunlight is very essential during photosynthesis, but with high intensity of sunlight, it has negative impacts as it kills plants especially at the tender age. Water is equally necessary for the growth of plants. However, its excess for long periods in the northern and southern parts of the country most plants may not survive extremity or flooding. The wind on the other hand, is equally associated with deforestation but destructive wind may cause breaking of tree branches as well as uprooting of trees which remove vital vegetation from the ground and thus, resulting into open ground or drought.

b) The Biotic agents like microbes, animals and other plants. The microbes include; fungi, bacteria and viruses are in this category. These in all, attack all parts of plants thereby killing plants off and making ground to become barren. Other plants especially some tall trees provide shade which retards the growth of their own seedlings and seedlings of other plant species. Also, some other plants produce toxic chemical substances which are poisonous to other species (Nwoboshi, 1982).

c) Man/Animals as agents of deforestation have the greatest impact on forests as without their interference, the forest would have remained intact. The impacts of man/animals include; over logging, overgrazing, urbanization due to improper control of migration, attempting industrialization, illegal mining, felling of trees without replenish or replacement, over-extraction or fetch-wood for fuel and ill-control of charcoal making as well as, uncaptioned and improper opening of forests to public for tourism, all these cause more untenable and damage to many Parks and Sanctuaries in Nigeria. While the impacts of animals such as; insects, rodents, worms and large herbivores which feed on trees can equally be felt to have impacts on deforestation in the country (Ogundele and Oladipo, 2016).

Expansion of Farming Land

About 60% of the clearing of tropical most forests are meant for agricultural settlement (Myers, 1994). But for the fact that, more than 80% of the Nigeria populace are into farming. Therefore, more people are found in agricultural resettlement and thus, more people are induced on deforestation in the country. During agriculture the site is prepared through under brushing and felling leading to deforestation through slashing and burning activity in tropical forests which is utilized during shitting cultivation has led to the permanent destruction of the rainforest (Nwoboshi, 1982). Mostly all reports indicated shifting agriculture as responsible for about one half of tropical deforestation and some put it up to two thirds (Chakravarty et al., 2012).

Urbanization and industrialization

Increase in population has led to several houses and infrastructure springing up everywhere, thereby threatening the forests (NEST, 1992). For instance, Nigeria had a forest area of about 60 million hectares in 1897, but after 100 years the country had only about 9.6 million hectares which represent a loss of 50 million hectares in 100 years (Carty, 1992). The sites for the University of Calabar as well as the sites of other first and second generation universities in Nigeria were highly forested areas. Similarly, the Army School of Artillery, the Nigerian Defence Academy and the

Mobile Police Training School together used approximately 7420 hectares of forest reserves of Kaduna state while 18, 390 hectares of Ajaokuta forest reserve in old Kwara state was used by the steel plant (Carty, 1992). The federal capital territory claimed approximately 27, 330 hectares of forest reserves (Carty, 1992; Aderounmu et al., 1992). Also, the construction of road networks, railways, ports complex, airports have led to considerable deforestation, and invariably the loss of vast fauna population. Akintoye (2014) has also identified the consequences of the Nigeria Liquefied Natural Gas (NLNG) Project on biodiversity losses, although in a mangrove ecosystem in Bonny local government area of Rivers state in Nigeria. The present site of the NLNG, at old Finima, is believed to be the breeding area for some marine species like turtles. Also, Akintoye and Utang (2012) identified that where industries are created and there are negative consequences on the immediate local environment and invariably the host communities, there is no guarantee that significant benefits will accrue to the indigenous population.

Logging

Sawn timber is imperative in construction activities for residential, recreational and industrial development (see figures 1 and 2). In many cases in Nigeria, trees are felled and sawn without any commensurate effort to replant them, for instance, Ekinta forest reserve (104 km^2) in Cross River State, south-south geo-political zone of Nigeria has been transformed from tropical high forests into grassland as a result of unsustainable agriculture and logging.

Mining and Extraction

As mining is very intensively lucrative, it is also very destructive and encourages deforestation (Mather, 1991; Sands, 2005). The mining area of land involved is quite small and it is not seen as a major cause of primary deforestation. Mining activity promotes development booms which may attract population growth but its consequence is deforestation. Moreover, Roads constructed to support the mining operations will open up the area to shifting agriculturists, permanent farmers, ranchers, land speculators and infrastructure developers. The construction of roads, railways, bridges and airports open up the land to development and bring increasing numbers of peoples to the forest frontier. If wood is used as fuel in mining operations and it is sources from plantations established for the purpose, it can cause serious deforestation in the region.

Over Exploration and Exploitation

The swamp forests of Southern Nigeria were previously protected from destruction or over exploitation due to their relative inaccessibility as a result of the swampy nature of the environment. However, today, these forests are being destroyed as a result of petroleum exploration, exploitation and spillage (Akachuku, 2007). Mining of several minerals in Nigeria such as bayrite, tin, coal etc has led to the destruction of the forests and scarification of the landscape.

Over Grazing

It is a well established fact that over grazing leads to a gradual change in vegetation from derived savannah to Sudan savannah as these animals feed on tree seedlings especially in the dry season when there is little grass to sustain them. These animals also feed on tree seedlings and branches of mature trees, thereby leading to deforestation (NEST, 1992).

Corruption and political Interference

The Food and Agricultural Organization (FAO) (2015) reports identified forest crime and corruption as one of the main causes of deforestation and warned that immediate attention has to be given to illegal activities and corruption in the world's forests in many countries (Chakravarty et al., 2014). Illegal forest practices may include the approval of illegal contracts with private enterprises by forestry officers, illegal sale of harvesting permits, under-declaring volumes cut in public forest, under pricing of wood in concessions, harvesting of protected free by commercial

corporations, smuggling of forest products across borders and allowing illegal logging, processing forest raw materials without a license (Chakravarty et al., 2014). In Nigeria poaching, farmers and Fulani in the forests is corruptly allowed by forest guards.

Fuel wood and Charcoal

In Nigeria as in most third world countries, firewood and charcoal production constitute the major source of fuel. This scenario is aggravated by the rampant, unusual and high cost of kerosene leading to a lot of pressure on the forests. It becomes difficult to prevent people from cutting down the forest for firewood when there is no cheap and available alternative. This alternative source of fuel is often perceived to have devastating ecological and environmental effects. While little attention is being paid by the governments, forestry institutions, NGOs, to legislate policy measures to control felling of unauthorized trees using for charcoal making in some rural and urban areas in Nigeria.

IMPACTS OF DEFORESTATION IN NIGERIA ENVIRONMENT

Deforestation in Nigeria has tremendously impacted that are not only threatened, depleted or endangered biodiversity of the forest ecosystem but it has negative on ecological, genetic and socio-economic influence on the environment. The details of the impacts are as follow:

Loss of biodiversity (Plants and Animals in the Environment)

In the vegetation regions of Nigeria, many trees like; shrubs, herbs and several plant species have been over exploited especially those with edible seeds; nuts and kernels, are now endangered as well as some assorted animals have been reduced, while some are in danger of extinction. Also, most primates like; chimpanzees and gorillas, guenons, mangabeys, drills (marine animals), are now endangered (Akachuku, 2007).

In reality, the lowland gorilla which is endemic to the Cross River National Park at Mbe Mountain is seriously threatened through hounding and habitat destruction. Several large animals like; elephants and other mammals such as hippopotamus, manatees and leopards had decreased tremendously within the ecosystems, have disappeared, while reptiles such as crocodiles, monitor lizards, alligators, royal python and boa (constrictors) have diminished. Also, several species of amphibians, fruit bats, fishes, snails, birds e.t.c are threatened, endangered or extinct. Most stable crops have been "lost" whereof several younger generations of Nigerians may not know them. These "lost" plants are of serious economic importance (food, medicine,) to the country. They include algae, mushrooms, roots, vegetables, tubers, fruit trees, culinary plants, medicinal plants e.t.c (Okojie, 1993). For instance, Akintoye (2003), Akintoye et al (2013) and Mfon (2003) in studies carried out in Cross River state, have confirmed that losses of biodiversity, from logging and unsustainable NTFPs collection are serious threats to forests conservation in Nigeria.

Atmospheric Pollution

Deforestation is one of the major causes of enhanced green house effect. Trees and other plants remove carbon in form of carbon dioxide from the atmosphere during the process of photosynthesis. Carbon dioxide is injurious to animals including man and as deforestation takes place, the few trees left cannot make use of the carbon dioxide, therefore, the excess carbon dioxide gets into the atmosphere causing global warming. Deforestation is estimated to contribute up to one third of all carbon dioxide. The water cycle is equally affected by deforestation as trees extract groundwater through their roots and release it into the atmosphere. When deforestation takes place, the region may not hold as much water which can lead to a much drier climate. [6]

[6] *http://en.wikipedia.org/wiki/deforestation.*

Environmental Calamities (Acid rain, Desertification and Flood)

With deforestation, most of the carbon dioxide produced by industries especially in the Niger delta cannot be absorbed by trees, therefore, acid rain is produced which damage roof tops and speeds up the weathering of buildings as well as chemically attacking plants and other living things. The Sahara Desert is encroaching into the southern parts of Nigeria and the encroachment is accelerated by deforestation. Also, there are incessant flood along the coastal areas of Nigeria and even in the north after torrential rainfall as the root of the trees which would have reduced the velocity of water runoff cannot serve the purpose because of deforestation.

Depletion of Soil and Water Resources

It has been established that most fishes and other aquatic animals breed under the root of some aquatic trees. With deforestation, some trees and animals' population become few, while large bare of land equally triggers the loss of several tones of soil from soil erosion leading to open bake land that reduced food production, creation of gully erosion and forced migration of people from the affected areas (see figure 3).

Figure 1. Logging in Nigeria environment
Source: Adopted from, Naij.com, media Ltd.2019

Figure 2. Forest depletion in Nigeria environment
Source: Adopted from, Naij.com, media Ltd.2019

Figure 3. Deforestation leading to erosion impacts in Nigeria [7]

Economic losses

The tropical forests destroyed each year amounts to a loss in forest capital valued at US $ 45 billion (Hansen, 1997). By destroying the forests, all potential future revenues and future employment that could be derived from their sustainable management for timber and non-timber products vanish.

[7] *http://en.wikipedia.org/wiki/deforestation.*

Social consequences

The social consequences of deforestation are many, often with overwhelming long-term impacts. In Nigeria and among the local communities, the arrival of the so-called modernization usually means the destruction/change of their traditional life-style and the breakdown of their social institutions mostly with their displacement from their ancestral home. The intrusion of outsiders destroys traditional life styles, customs and religious beliefs which intensifies with infra-structure development like construction of roads which results into frontier expansion often with social and land conflicts (Schmink and Wood, 1992). The most immediate social impact of deforestation occurs at the local level with the loss of ecological services provided by the forests. By destroying the forests, we risk life of quality livability, risk the stability of climate and local weather, threaten the existence of other species and undermine the valuable services provided by biological diversity (Schmink and Wood, 1992).

RESILIENCE STRATEGIES TO REDUCE DEFORESTATION IN NIGERIA

The ways to reducing deforestation in Nigeria must go hand in hand with improving the welfare of stakeholders such as; the government of all cadres, cultivators, pressure group at the forest frontier among others. Any policy that does not carry other along is blemished and undesirable. There are no general solutions and strategies to challenges of deforestation as they vary from one region to the others or environment, as policies of government are not static as they may change over time.

The following are suggested efforts to control deforestation in Nigeria, they include:

- Creation of Forest Reserves for Research Education

These are areas delineated and gazetted by government for use as; making of useful logs for electricity and props, selling of forest produce and biodiversity through the creation of strict nature reserves and for research awareness in wetland conservation environment. All these have both social and economic advantages for the government, the community and the general masses.

- Legislation

In Nigeria from past to present, many laws and edicts have been enacted to control and enhance forest conservation. But the associate problem is that, these laws have not been properly utilized, as there are still found some forest defaulters who use forests for other nefarious activities like; kidnapping dens, cattle rustlings, and hidden places for highway robbers. Thus, there should be proper enforcement of policies measures to curb the menace.

- Rainforest Management

Many techniques have been utilized to manage the rainforest. These methods include; enrichment planting, tropical shelter wood system, taungya system, plantation establishment, and malayan uniform system etc. it is unfortunate that these management techniques have not been able to save the rainforest in Nigeria. Thus, new forest conservation methods must be encouraged through community participation and enlightenment programmes (Ogundele and Oladipo, 2016).

- Encouragement should be given to private developers of forests

Incentives like; free seedling distribution and free land holding should be provided for forest developers and cultivators. This will not only encourage more people into the trade, but sustains and increases Forest Area Plantation (FAP) and Area Permanent Reserve (APR) for timber production. A sustainable policy framework is important to give room for a progressive growth in the forestry industry throughout the country.

- Lessening emissions from deforestation and forest degradation

Many international organizations including the United Nations and the World Bank have begun to develop programmes to curb deforestation mainly through Reducing Emissions from Deforestation and Forest Degradation (REDD) which use direct monetary or other incentives to encourage developing country like Nigeria to limit and/or roll back deforestation. Significant work is underway on tools for use in monitoring developing country adherence to their agreed REDDS targets (Chomitz et al., 2007).

- Increase the area and standard of management of protected areas

The provision of protected areas is fundamental in any attempt to conserve biodiversity (Myers, 1994; Myers and Mittermeier, 2000). Protected areas alone are not sufficient to conserve biodiversity; rather, they should be considered beside a wider stretch of areas and at a strategy place to conserve biodiversity. The minimum area of forest to be protected is considered to be 10 per cent of total forest area (Anonymous, 2010).

- Encouraging substitutes For Timber

Where tropical or other timber is used, other woods or materials could be substituted. We can stop using timber and encourage others to follow suit. Labeling schemes, aimed at helping consumers to choose environmentally friendly timbers are currently being discussed in many countries, Thus, Nigeria should be urged to do the same (Anonymous, 1990).

- Increase area of forest plantation

Increasing the area of forest plantations by using vacant lands, waste lands and marginal lands especially along road sides, railway tracts, on contours lines, avenues, and boundaries as well as on land not suited for agricultural production should have net positive benefits. Planting trees outside forest areas will reduce pressure on forests for timber, fodder and fuel-wood demands for use. In general, where trees fell, afforestation should take place in the areas as replacement (Anonymous, 2010).

CONCLUSIONS AND RECOMMENDATIONS

Finally, one can categorically conclude by saying that, most forest destructions in Nigeria is carried out by poor people, who are denied access to land and these people depend on the forest for their existence. Other infraction and causes include settlement expansion, large scale agricultural and development projects. The Nigerian rainforest has been seriously encroached upon and afforestation programmes in the country is inadequate. Also, most Nigerians are not aware of the consequences of deforestation; accordingly, awareness should be created. The achievement of the MDGs in the rural areas depend largely on the potentials of the flora and fauna species, some of which have not yet been discovered and documented by researchers. Women and their households' dependence on NTFPs, medicinal preparations, indigenous knowledge, building materials, good soils for agriculture, fresh water, industrial raw materials, erosion control, and exotic crops for domestication and so on, which in turn depends on the preservation of the forests. [8]

In view of the importance of forests and the consequences of deforestation, the under listed recommendations, which undeniably will help in the realization of the MDGs are made:

- agricultural science subject in secondary schools should be expanded to include relevant aspects of forestry, indigenous knowledge, rural development, agro-forestry and environmental sciences;
- budgetary allocations to all the three tiers of government should be increased and released promptly for forestry operations;
- the private sector and NGO's should be encouraged to participate in biodiversity conservation through grants and tax rebates;
- forest reserves should be established in mangrove ecosystem for in-situ conservation;
- researches should be embarked upon by foresters with the view to developing fast growing tree species as well as those resistant to fires and pathogenic attacks;
- through granting of grants, researchers can study both plants, forests and animals in-situ and benefits of this are reflected in institutions of higher learning and among specialists in the field of agriculture and biodiversity;
- rich and developed countries should fund afforestation programmes in Nigeria. Nigeria should stop gas flaring, rather the gas should be bottled and the cost subsided for rural people in order to reduce the pressure on fuel wood;
- environmental laws should be fully enforced and implemented in order to serve as deterrent to defaulters;

[8] *http://en.wikipedia.org/wiki/Millennium*

- efforts should be made to domesticate some wild animals in order to reduce bush burning and hunting sprees;

- intensive agriculture whereby droppings of animals are used to increase fertility of the soil, thereby, utilizing a particular area for a long period should be encouraged. This will reduce the practice of shifting cultivation. Also, agro forestry and mixed cropping leading to the multiple use of the land should be encouraged;

- bush burning should be discouraged and where it is unavoidable, fire tracing should be embarked upon to prevent the fire from spreading beyond the anticipated area. Appropriate sanctions should be applied to defaulters;

- efforts should be made by the necessary institutions to encourage participatory forest management strategies merging the ideas and priorities of government, non-governmental organizations, foreign donors, forest communities, forest clubs and other stakeholders.

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DEFORESTATION AND MICRO-CLIMATE OF ILORIN AND ITS ENVIRONS

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Abstract: Deforestation is the permanent destruction of forests in order to make the land available for other uses This research is aimed at assessing the level of deforestation and how it affects the micro-climate of Ilorin and its environs with a view to lookup the relationship that exists between deforestation and micro-climate of the study area. The statistical tool to be used are both descriptive (Mean, Tables & Charts) and inferential statistics (Correlation and regression Analysis). The study reveals that there is a significant relationship between deforestation and micro-climatic variables with r^2= 0.997 for precipitation, 0.888 for maximum temperature, 0.201 for minimum temperature, 0.432 for solar output, -0.873 and -0.797 for relative humidity and evapo-transpiration respectively. The study concludes that deforestation greatly influences the microclimate of the study area and further recommends enlightening the public through organisation of workshops, seminars, jingles on media as well as enacting of laws that prohibits deforestation.

Key words: Deforestation, Climate, Micro-climate, Vegetation Cover

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INTRODUCTION

Deforestation is the conversion of forested areas to non-forest land for use such as arable land, pasture, urban use, logged area, or wasteland. Deforestation can also be seen as removal of forests leading to several imbalances ecologically and environmentally and results in declines in habitat and biodiversity (Ahmed and Aliyu, 2019). Urbanization, Mining, Fires, Logging and Agricultural activities are few of the causes of deforestation (Andronache et al., 2019). According to the World Resources Institute (2011), loss of forests contributes between 12 percent and 17 percent of annual global greenhouse gas emissions. Deforestation continues to be a major concern not only in small cities or towns but also on the world scale at large as it appears to be a threat to man and his environment.

Deforestation in itself has been noticed to have accelerated in countries of the tropical region with Nigeria inclusive. Although reliable estimates are not available, it has been put at

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approximately 285,000 ha annually. At this rate of deforestation, 50% of the country's relatively small forest land area of just 10% of total land area was eliminated in the year 2015 (Aruofor, 2001).

Forests are of great importance to the environment, it furnishes us with the basic necessities, providing habitats for a variety of species, helps to control and moderate climate, prevent soil erosion and flooding, but despite all these benefits that is obtained from forest ecosystems, the clearing of forests and deforestation brought about by human activities have contributed to the continuous decline of the forests. Deforestation is clearing Earth's forests on a massive scale, often resulting in damage to the quality of the land. Su et al., (2011) reporting (Dove, 1993) indicated that poverty draws people to exploit the products of the tropical forest, clearing and exploiting it for immediate gains. Dolisca et al., (2007) explained that pressures brought about by land tenure system and the growing population sizes are some of the identified causal factors of deforestation.

World Resources Institute (2005) explained that over 11 million hectares of tropical forest are cleared yearly and it is estimated that at present rate of use at least 225 million hectares of tropical forests was cleared in the year 2000, Shifting cultivation is by far the most important cause and it accounts for about 70% of the total deforestation in the Africa region. Farmers cut forests to provide more room for planting crops or grazing livestock, ranching and development, unsustainable logging for timber, and degradation due to climate change and this impacts people's livelihoods and threatens a wide range of plant and animal species as 46-58 million square miles of forest are lost each year equivalent to 36 football fields every minute (World Wildlife Fund, 2017).

Su et al., (2011) indicated that poverty draws people to exploit the products of the tropical forest, clearing and exploiting it for immediate gains. Dolisca et al., (2007) explained that pressures brought about by land tenure system and the growing population sizes are some of the identified causal factors of deforestation. According to Geist and Lambin (2002), demographic, institutional, cultural factors, economic and technological policy all contribute to the underlying driving forces of deforestation.

Urban and residential area expansion cause significant forest loss, both in the consumption of building materials and as a source of land. With the rise of the need to develop, forested areas are quick to be depopulated to provide logs for man's construction, and a host of other amenities they could derive from the environment (Jacob et al., 2015). These changes cause urban regions to become warmer than their rural surroundings, forming an "island" of higher temperatures in the landscape (EPA, 2017). Therefore, the heat tends to spread to other parts of the city, affecting its microclimate. Vegetation covers serving as carbon sinks i.e. they help to absorb the excess carbon dioxide in the atmosphere are cut down leading to excess carbon dioxide in the atmosphere which in turn causes excessive warming of the surrounding (Royal Meteorological Society, 2017). As rates of deforestation climb and shifts in local climate become more pronounced, the need to understand the relationship between forest cover change and temperature will become more urgent. The more forests we clear, the more we increase risks for food production due to changes in temperature (Field et al., 2012).

THE STUDY AREA

Ilorin is located on latitudes 8º24′ and 8º36′ North of the equator and longitudes 4º10′ and 4º36′ East of the Greenwich meridian (figure 1). It has an area of about 468 km². It is 200 km from Abeokuta, 512 km from Sokoto, 574 km from Calabar, 1013 km from Maiduguri and 494 km from Aba.

Ilorin experiences humid tropical climate characterized by wet and dry seasons (Olaniran, 2002). The wet season commences towards the ending of March and ends in October. The dry season starts November and spans to February. The dry season in Ilorin is characterized with dusty wind from the northern part of Nigeria referred to as the Harmattan and hot temperature which extend from November to March. The wet season is characterized with high humidity extending from April through November, extremely high temperatures is usually experienced between February and April which usually exceed 30ºC (Jacob et al., 2015). According to Olaniran, (2002) the mean annual total rainfall in Ilorin is 1200 mm. The temperature of Ilorin

ranges from 33 ºC to 35 ºC from November to January while from February to April; the value ranges between 34 ºC to 37 ºC. The climate of Ilorin supports the growing of tall grass vegetation dotted with medium-sized trees.

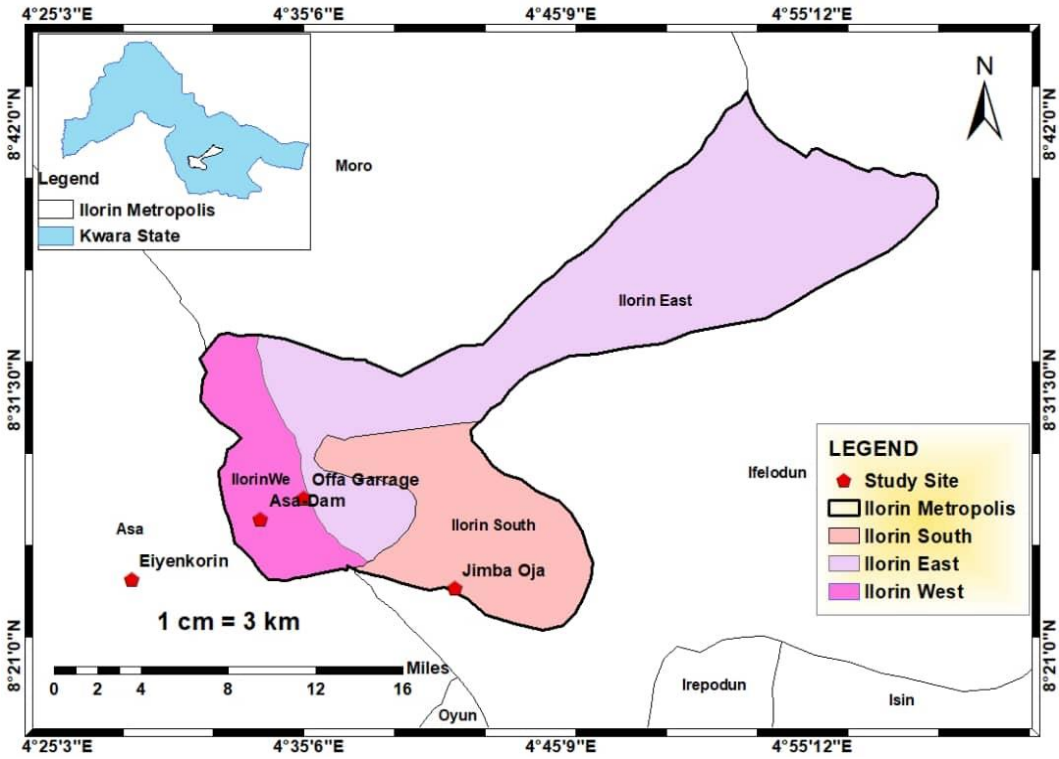

Figure 1. Map of Ilorin Metropolis
Source: Adopted from Kwara State Survey (2018)

Urbanization process is fast replacing the Guinea savannah vegetation in the city with artificial (paved) surfaces with consequent effect on runoff generation, hence, frequent occurrence of flooding (Iroye, 2017), sediments yield (Jimoh, 1999) and erosion (Jimoh, 2000). The soil in Ilorin is formed under the grassland savannah cover and belong to the soil group called Ferruginous soil. This is an ideal soil for the growing of crops such as yam, cassava, and maize, among others. This type of soil yields readily to the agents of denudation when exposed and not protected by vegetation cover.

The prominent land form is Sobi Hill. Ilorin is underlain by Precambrian of basement complex which are neither porous nor permeable except in places where they have been deeply weathered or zones of weakness. Large area of the town is also underlain by sedimentary rock, which contains both primary and secondary laterites and alluvial deposits.

The major rivers are Asa, Agba, Alalubosa, Okun, Osere and Aluko. Some of these rivers drain into river Niger or river Asa (Oyegun, 1986). The drainage system of Ilorin is dendritic in pattern due to its characteristics. The most important river is Asa River which flows in south-northern direction. Asa River occupies a fairly wide valley and goes a long way to divide Ilorin into two parts namely the Eastern and the western part.

The population of Ilorin as at 2006 census was put at 777,667 (Federal Republic of Nigeria Official Gazette, 2009). Majority of the inhabitants are Yoruba, Hausa and very few Igbo's. Bulk of the land area is used for commercial and residential purpose; small and large-scale industries

characterize most its environment. The land use of Ilorin some years ago used to be majorly agriculture and forested areas with a few built up areas. The emergence of urbanisation has brought about decrease in the forested areas over time paving way for more residential areas, industries, schools etc. due to increase in population.

MATERIALS AND METHODS

The data used for this research was gotten from satellite images showing the rate of deforestation in Ilorin for about 30 years. The satellite images were gotten from Landsat, and some information's on methods for the extraction of satellite image data are presented in Table 1.

Table 1. Shows the methods of extraction of satellite image data
Source: Authors computation, 2018

Data		Resolution	Source
Landsat	TM 1991	60 m	Global Land cover facility / European Space Agency
	TM 1998	30 m	
	ETM+ 2003	30 m (15 m panchromatic)	
	ETM+ 2013	15 m (10 m panchromatic)	
	OLI 2018	15 m (10 m panchromatic)	

The steps carried out are Image Pre-processing (Image normalization, Image sub-setting, Image pan-sharpening, Digital Number (DN) to Reflectance Conversion), Image Classification and Feature Extraction (Train signatures, Image segmentation, Support vector machine classification), Estimating Evapotranspiration, and Interpolating Climatic variables. Four satellite images are used for this research. Each satellite images were taken at intervals. The intervals are between 1991-1998, 1998-2003, 2003-2013, and 2013-2018. Descriptive statistics used were Mean, frequency distribution tables and bar charts and correlation matrix analysis were used to determine the relationship between deforestation and the microclimate of the Ilorin.

RESULT AND DISCUSSION

Ilorin had smaller built-up areas which was just at the centre of the city in 1991. Though the built was gradually spreading into forested areas. The forested areas, marshlands, grasslands and farm beds still had much of the landmass (figure 2). Since the built-up areas and the bare surfaces are smaller, with more vegetation, the temperature at that time was cooler since the urban heat island effect was low. The vegetation affects the micro-climate on d long run mostly through evapotranspiration and albedo (Royal Meteorological Society, 2017).

In the 1998 image, built-up areas have extended towards the forested areas, grasslands/farmlands, and marshlands/streambed. This is due to the expansion of the city because of increase in population. Also, the bare surfaces have increased leading to increase in temperature during this time. The changes in the size of built up areas, bare surfaces, forested areas, grasslands, marshlands and waterbodies are almost negligible compared to figure 3 in 1991.

The built-up and the bare surface areas have eaten deep into the forested areas by 2003. Urbanization is a major factor here, because the population in the city has greatly increased, more houses, schools and even commercial centres have been built (Figure 4). The forested areas, marshlands, and grasslands have paved way for more built-up and bare surfaced areas. Deforestation has greatly occurred; large number of trees has been cut down. When this happens, CO_2 is released in large amounts to the atmosphere causing excessive warming in the city. Since urbanization is at its peak, the urban heat island effect is inevitable (World Wildlife Fund, 2017).

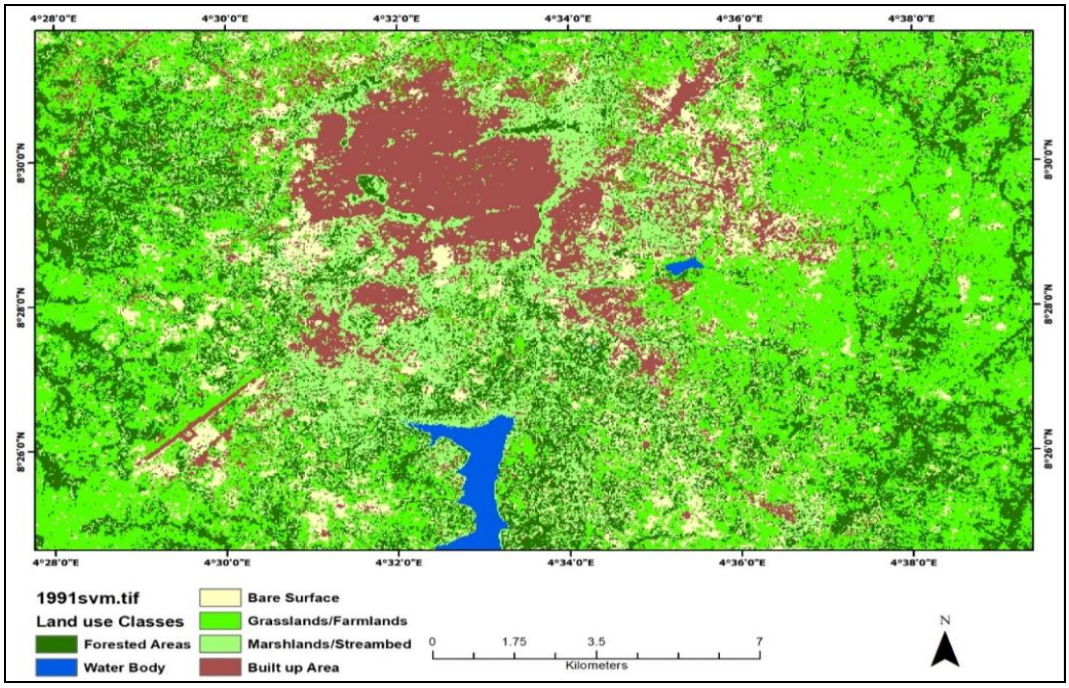

Figure 2. Rate of deforestation in 1991
Source: Landsat Images, 2018

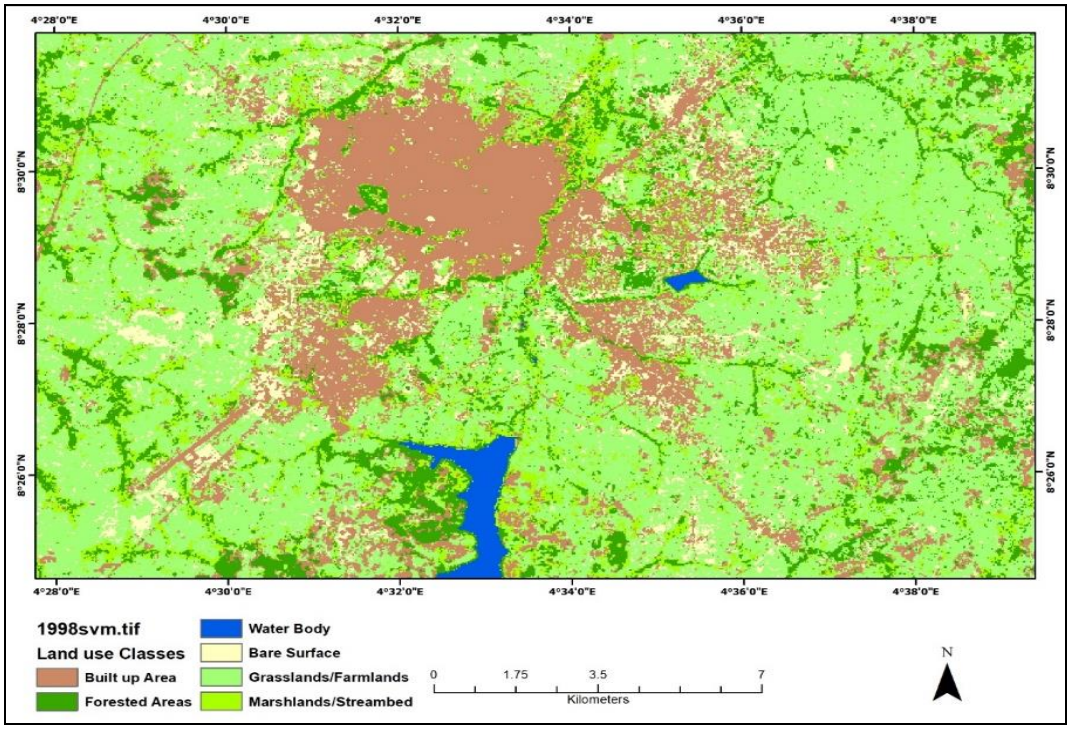

Figure 3. Shows the land use in Ilorin in 1998
Source: Landsat Images, 2018

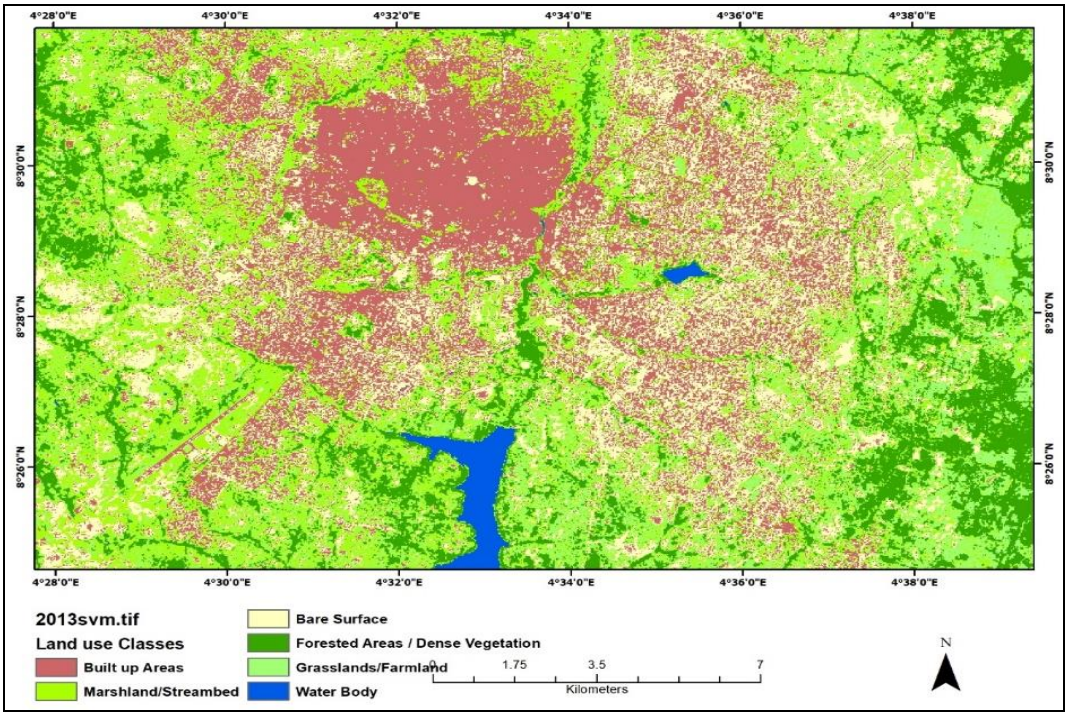

Figure 4. Rate of land use in Ilorin in 2003
Source. Landsat Images, 2018

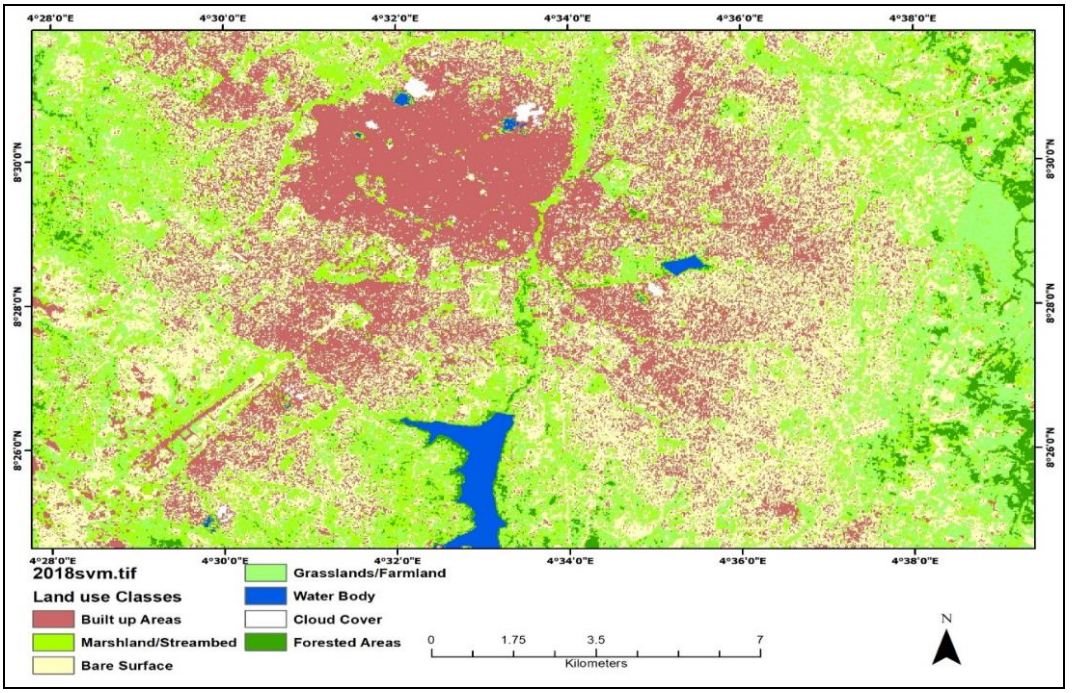

Figure 5. Showing the land use of Ilorin in 2018
Source. Landsat Images, 2018

There has being a great expansion of the city, and only very few patches of forested areas, marshlands and grasslands left. Gradually, the built-up areas and bare surfaces has expanded and is still expanding till date as shown in figure 5. Forested areas have largely depreciated implying that with the current trend of deforestation, there will be little or no vegetation cover in about two decades from now. The micro-climate has been greatly affected because high temperature changes due change in land use pattern. This is not farfetched from the works of Jacob et al., (2015) reporting that forest have given way to built-up areas and grassland in most areas between 1972-2014 in Ilorin. Analysis of land surface temperature which shows an increase in urban land surface temperature was due to reduction of forested areas and grasslands.

DEFORESTATION AND CLIMATIC VARIABLES RELATIONSHIP

The climatic variables for the months/days of the satellite image was derived from the satellite image while gridded datasets for the period was also used to generate micro-climatic data for the study area. They are Land surface temperature, Evapotranspiration, Temperature, Rainfall, Relative Humidity and Solar Radiation

Table 2. Micro-climatic variables for the study
Source. Authors computation, 2018

Date	Forested Areas Km^2	Max Temp ^oC	Min Temp ^oC	PPT mm/day	Wind m/s	RH kPa	Solar MJ/m2.day	ET mm/day
3/5/1991	134.71	42.10	22.93	0.00	2.69	54.38	12.63	36.85
3/20/1998	128.6	40.90	19.94	0.00	2.07	43.22	26.14	33.20
3/8/2003	120.51	44.20	22.06	0.00	2.56	50.06	25.08	38.75
3/15/2013	124.11	46.70	23.34	0.00	3.13	47.40	25.49	41.75
3/5/2018	40.64	33.80	21.41	0.42	3.01	69.60	28.20	28.65

There was a decrease in the size of the forested area from 134.71 km² in 1991to 128.6 km² in 1998, 120.51 km² in 2003, a slight increase in 2013 with 124.11 km² and downward trend in 2018 with 40.64 km². These changes across the time frame caused for variation in the various climatic variables considered as shown in Table 2.

Table 3. Relationship Deforestation and Micro Climatic Variables
Source. Authors computation, 2018

Variables	**Deforestation rate**	**Max Temp.**	**Min Temp.**	**PPT**	**Wind**	**RH**	**Solar Output**	**ET**
Deforestation	1							
Max Temp	0.888*	1						
Min Temp	0.201	0.479	1					
PPT	-0.997*	0.912*	0.204	1				
Wind	-0.430	-0.059	0.771	-0.418	1			
RH	-0.873	-0.784	0.147	-0.887*	0.587	1		
Solar Output	-0.432	-0.217	-0.450	-0.372	0.001	-0.015	1	
ET	0.797	0.976*	0.652	0.823	0.144	-0.630	-0.261	1

Table 3 presents the results of the correlation between deforestation and micro climate in the study area. The result shows that the coefficient of correlation for maximum temperature (0.888*) is positive and significantly related to deforestation; meaning that increase in deforestation leads to increase in maximum temperature. This result is similar to the findings of European Commission's Institute for Environment and Sustainability (ECIES) 2016 showing that

both global forest cover and land surface temperatures, that forest loss causes an increase in temperature variations in areas of deforestation; which tends to lead to an increase in mean and maximum air temperatures.

Removal of vegetal cover increases reflection of incoming solar radiation which leads to excess energy in the atmosphere resulting to increase in temperature. Furthermore, plants absorb excess carbon in the atmosphere for photosynthesis which reduces carbon which is a greenhouse gas that results to global warming. Removal of plants increases the circulation of carbon in the atmosphere resulting to increase in greenhouse gases causing global warming. Global warming results to increase in maximum temperature in the area. This result is corroborated by Gorte (2010) who stated that forests act as what is called a "carbon sink". Carbon sink is the soaking up of carbon dioxide that would otherwise be free in the atmosphere and contribute to ongoing changes in climate patterns. Deforestation undermines this important carbon sink function (Gorte, 2010).

As indicated in Table 3, the result of Precipitation with coefficient of correlation (-0.997*) is negative and significant. This implies that there is a significant relationship between deforestation and precipitation. Other results in Table 2 shows that minimum temperature (0.201), wind (0.430) and solar output (0.432) is directly related to deforestation but not at a significant level. This implies that increase in deforestation lead to increase in minimum temperature, wind and solar output. In other vein, relative humidity (-0.873) and Evapotranspiration (-0.797) is inversely related to deforestation; meaning that increase in deforestation leads to a decrease in relative humidity and evapotranspiration.

As deforestation increases in the area, rainfall decreases. Plants contribute to rainfall formation process through evapotranspiration. This result is supported by Field et al., (2012) in their study who revealed that forests absorb more rainwater and transpire it as water vapour later. This phenomenon, called evapotranspiration, causes cooling. These two competing biophysical effects could determine whether at a specific location or during a specific time of the day or season of the year, a forest could cause local cooling or warming and, by extension, whether clearing a forest could leads to decrease in rainfall (Field et al., 2012).

CONCLUSION AND RECOMMENDATION

In conclusion, there is a significant relationship between deforestation and the microclimate of the Ilorin and the study recommends community participation in the forestry conservation and protection initiatives should be made mandatory. This will encourage these communities to device indigenous methods that will help to stop under and over exploitation of forest. Also, due to the nature and extent of forest destruction, efforts to stop the human activities can be complemented by laws and regulation at governmental and organizational levels. Penalties should also be put in place for violators.

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USAGE OF CRASH HELMET AMONG COMMERCIAL MOTORCYCLISTS IN ILORIN, NIGERIA

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Abstract: This study examined usage of helmet among commercial motorcyclists in Ilorin, Nigeria. Simple random sampling was used to select 120 motorcyclists, who were surveyed with a structured questionnaire. Descriptive statistics, including percentages and mean scores were used to analyse the data. Results showed that only 14.2% of the riders fully abide with the helmet law. High mean scores of 3.81 and 3.32 for 'helmet usage is important' and 'helmet prevents head injury' respectively, however showed that most riders are aware of the protective role of crash helmets. It is recommended that there should be stricter enforcement of the helmet law.

Key words: Commercial motorcycle, crash helmet, road safety, public transport

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INTRODUCTION

Unprotected road users such as pedestrians, pedal cyclists and motorcyclists constitute the most vulnerable group on the road because they are directly exposed to injury from road crashes. For instance, in some cities of the developing world up to 80% of road fatalities may relate to this group of road users (Gbadamosi, 2006; Global Road Safety Partnership, 2014). Motorcyclists in particular are known to have poor safety records and most motorcycle accidents are usually fatal. For example, in the United Kingdom the mortality rate for motorcyclists is twice that of pedal cyclists and more than 16 times for car occupants (Department of Environment, Transport and the Regions - DETR, 2000). The US National Highway Traffic Administration (2002) also classified motorcycles as the most dangerous vehicles to drive. Similarly, 70% of road fatalities in Thailand involve motorcyclists (Global Road Safety Partnership, 2014).

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The emergence of motorcycles as means of public transport in Nigeria was encouraged by the high cost and shortage of transport services, such that supply could not match the demand for transport services in both urban and rural areas (Olubomehin, 2012). Motorcycles have become widespread as means of transportation because of their high manoeuvrability which is a great advantage in heavy traffic (Olakulehin et al., 2015), ability to pass along narrow paths and relatively affordable costs as compared to motor vehicles. As rightly observed by Ogunrinola (2011) motorcycles have become indispensable for transporting people and their goods and also serve as source of employment for large number of people in the country. However, despite its positive contributions, commercial motorcycle operation is known to have many negative effects in the country. For instance, apart from significantly contributing to the increasing trend of road traffic accidents, commercial motorcycle operation is known to negatively affect agriculture by attracting labour from farming. In addition, due to their high manoeuvrability motorcycles are increasingly being used to perpetrate criminal activities like armed robbery, assassinations and other heinous crimes in the country (Falope, 1991; Olubomehin, 2012; Adefalu et al., 2013).

The rate of road traffic accidents has increased with the introduction and spread of motorcycles as means of public transportation in Nigeria. For example, motorcycles alone accounted for 31% of road traffic accidents in the country from 2000 to 2005, while cars, luxury buses, mini buses and vans jointly contributed 52%. Trailers, tippers and articulated vehicles contributed 17% to road crashes during the same period. It has been estimated that the chances are 8:10 that a motorcycle accident will result in death or serious injury (Federal Road Safety Commission - FRSC, 1989; Gbadamosi, 2006; Olusayo et al., 2015). Increasing trend of involvement of motorcyclists in road crashes in Nigeria has been attributed to the uncoordinated mode of operation and low level of compliance with road safety regulations (Gbadamosi, 2006; Tunde et al., 2012). The high rate of use of intoxicants as performance enhancers among commercial motorcyclists is also seen as a contributory factor to the high trend of their involvement in road crashes in the country (Adisa, 2010). Motorcyclists who are high on drugs or other forms of intoxicants are not likely to observe traffic rules, are more likely to engage in risky behaviour, disobey road signals and less likely to protect themselves with crash helmets (Branas and Knudson, 2001; Adisa, 2010; Johnson and Adebayo, 2011). Some scholars have also identified the role of what has been termed “road traffic immune delusion syndrome”. This is when drivers believe in the efficacy of charms or some supernatural power to protect them from injuries or death in case of accident (Iweze, 2011; Olusayo et al., 2015).

The use of crash helmet is known to significantly reduce fatalities among motorcycle operators and passengers. For instance, the US Centre for Disease Control and Prevention (2009) noted that helmet use prevented as much as 37% fatalities among motorcycle operators and 41% of fatalities among passengers. In 2010 alone, helmet use saved the lives of 1,544 American motorcyclists, and an additional 709 lives might have been saved if all motorcyclists had worn helmets. Motorcyclists with no helmets were also found to be over three times more likely to suffer brain injury compared to those who wear helmet (The United State National Highway Traffic Safety Administration / NHTSA, 2012). Higher incidence of head and cervical injuries and mortality in unhelmet patients compared to helmeted ones have also been observed in Nigeria (Solagberu et al., 2006). According to the FRSC (1989) most fatalities among motorcyclists are due to head injuries which could have been prevented if motorcyclists were wearing crash helmets.

Some factors have however been found to be responsible for non-usage of helmet among motorcyclists in various parts of the world. These include the notion that helmet usage increases rather than decreases the risk of an injury by reducing field of vision and creation of discomfort (Dandona, 2005). Others are inconvenience of removing helmet in order to receive phone calls, problem of storage to prevent being stolen when not in use and inconvenience of wearing helmet in hot weather (Dandona, 2005; WHO, 2006; Solagberu et al., 2006). Rate of helmet usage has however been found to rise with increasing level of education (Swaddiwudhipong et al., 1998) and age of riders (Hung et al., 2006; Ackaah and Afukaar, 2010).

Various studies in Nigeria have indicated that compliance with road safety regulations including wearing of crash helmet by commercial motorcyclists is low (Adisa, 2010; Johnson and Adebayo, 2011; Tunde et al., 2012; Olusayo et al., 2015; Oyelade et al., 2015). For instance, it is common occurrence to find both the rider and the passenger riding without crash helmets. Oni et al., (2011) noted that in Lagos State, only 12.4% of motorcyclists made use of crash helmet. Relatedly, in a study in Ogbomoso, Oyo State, Oyelade et al. (2015) found that while the rate of use of helmet among commercial motorcyclists was generally low, married riders more regularly use helmets compared to unmarried riders. A study on Ilorin city by Yusuf et al., (2014) found that only 5.8% of motorcyclist who sustained head injury wore helmet at the time of crash. While over 70% of those affected falls within the economically active age group of 15-44 years, brain injury, skull fracture and associated injuries to the face were found to be very common among the victims. They concluded that many of these injuries might have been prevented or the severity reduced if the riders were wearing crash helmets.

While road traffic/safety officials have continued to struggle to enforce the use of helmet among motorcycle riders, presently it has become impossible to enforce its use on their passengers. Motorcycle passengers have refused to use helmets (which are expected to be provided by the operators) due to fear of catching skin diseases or coming under black magic spell. People fear being infected with infections like scabies and ring worms among others. It is also common belief that helmets could be laced with black magic spells that could make the wearer unconscious so that they could be easily robbed (Oboh, 2009) or even kidnapped for ritual purposes.

The high rate of involvement of commercial motorcyclists in road accidents and various forms of criminal activities have resulted in the outright ban or restriction of their operations in some cities across the country. Even the National Council of Transport in its 2014 national conference called for the proscription of commercial motorcycles nationwide to reduce accidents and ensure safety on Nigerian roads. The Council further called for the adoption of safer and more efficient transport systems in the country (Blueprint Newspapers Online, 2014). While also making reference to the poor attitude of commercial motorcycle operators to traffic rules and regulations and their high rate of involvement in road crashes, the Kwara State command of the FRSC stressed its support for the proposed proscription of their operations averring that such ban would reduce crashes on the roads (Ilorin.Info, 2017). However, the Federal Government has opposed the banning of commercial motorcycles because of the negative effects such ban may have on the economy. For instance, while noting their vital role in the economy in terms of creation of employment and provision of cheap transportation services, the Minister of Transport, Rotimi Ameachi suggested the introduction of training programmes for the operators to improve their adherence to road safety regulations (The Eagle Online, 2017). Consequently, in view of these important contributions of commercial motorcycles to the economy, many states such as Kwara State have resisted the temptation of proscribing or even restricting their operations. Therefore, in spite of its poor safety record this mode of transportation has remained as an important means of public transport in Ilorin city. While previous studies have also examined the usage of crash helmet among motorcyclists in other parts of the country (Oyelade et al., 2015; Olakulehin et al., 2015) this study examined the usage of crash helmet among commercial motorcyclists in Ilorin city. The study is limited to only the operators (riders) because there is no enforcement on usage by passengers. It specifically focuses on the prevalence of helmet use among the operators and the level of awareness of the motorcyclists on the benefits of using crash helmet.

MATERIALS AND METHODS

The study was conducted in Ilorin the Kwara State capital. It lies on the geographical coordinates of latitude 8º 3' N and longitude 4º 33' E in the North Central region of Nigeria. The city covers an area of about 100 km square (Kwara state Diary, 1997; Usman and Akinola, 2017). Ilorin metropolis consists of 26 political wards based on Independent National Electoral

Commission's (INEC) (2010) delineation of wards. These political wards are spread across parts of three Local Government Areas (Ilorin East, Ilorin West and Ilorin South). Twelve (50%) political wards were chosen for the study using simple random sampling technique, through ballot. The selected wards are Baboko, Gambari I, Akanbi IV, Balogun Fulani II, Adewole, Zango, Ogidi, Magaji Ngeri, Okaka II, Alanamu Central and Oke-Ogun wards. One motorcycle park was then chosen from each of the wards through simple random sampling, giving a total of twelve motorcycle parks (figure 1).

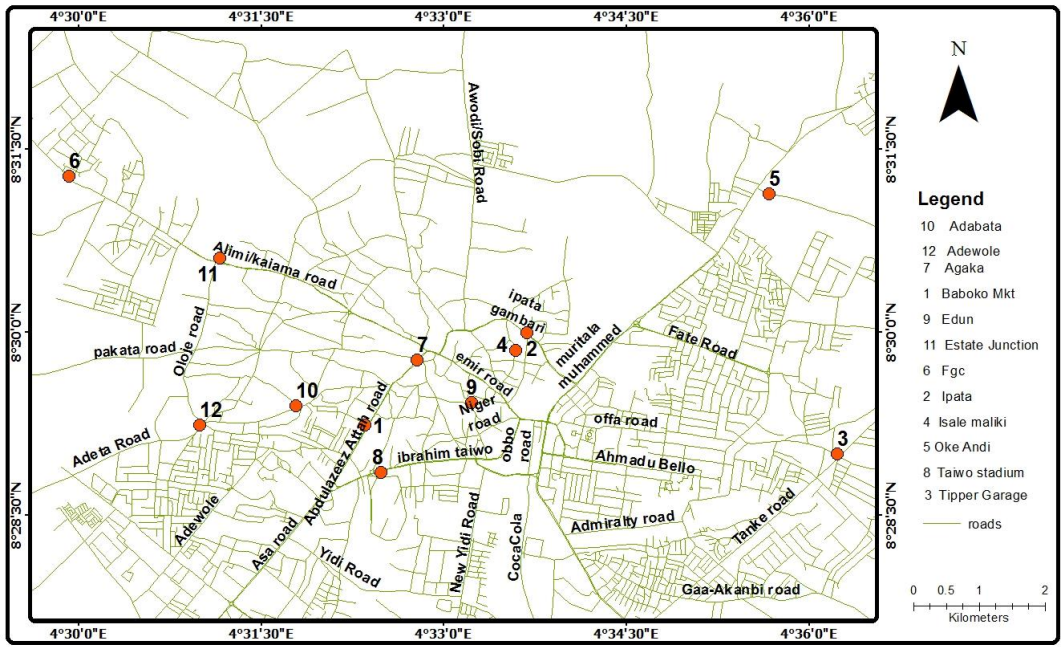

Figure 1. Map of Ilorin city showing the sampled motorcycle parks
Source: Adapted from Kwara State Ministry of Lands and Housing, 2013

Ten registered motorcyclists were then sampled from each of the twelve parks giving a total of 120 motorcyclists. The survey was conducted at the parks using a structured questionnaire. The sampled motorcyclists were chosen based on their willingness to participate in the study. Descriptive statistics including frequency distribution, percentages and mean scores were used to analyse the data.

RESULTS AND DISCUSSION

Socio-Economic Characteristics of the Respondents

All the respondents were found to be males and majority (71.9%) fall within the highly productive age group of 18-40 years (table 1). This is in line with the result of many other studies that commercial motorcycle operators mostly fall within the economically active population (Adisa, 2010; Tunde et al., 2012; Yusuf et al., 2014). The results further show that as high as 74.2% of the respondents have some formal education although, 33.3% of them did not go beyond primary school. The high proportion of the educated among the motorcyclists is not surprising because unemployment has been attributed to be a major factor pushing the youth into commercial motorcycle operation in the country (Ogunrinola, 2011). Table 1 also shows that 46.9% of the respondents earned above 20,000 Naira ($64.1) per month out of whom 8.3% earned above N40,000 ($128.2) per month. It is also evident from the results that commercial motorcycle

operation is a very important source of income particularly noting the fact that the minimum wage in the country is just N18,000 ($57.7) per month. It is therefore expected that the occupation will continue to attract more economically active members of the society if the present high level of unemployment put at 18.8% (National Bureau of Statistics / NBS, 2018) persists.

Table 1. Socio-Economic characteristics of the respondents
(Source: Field Survey, 2017)

Age		
Respondents	Frequency	%
18-30	47	39.2
31-40	38	31.7
41-50	27	22.5
50-60	8	6.7
Total	120	100.0
Marital Status		
Single	61	50.8
Married	59	49.2
Level of Education		
No formal	31	25.8
Primary	40	33.3
Secondary	34	28.3
Tertiary	15	12.5
Monthly Income **		
< ₦10,000 ($32.06)	13	10.8
₦10,001 - ₦20,000	52	43.3
₦20,001 - ₦30,000	23	19.2
₦30,001 - ₦40,000	22	18.3
Above ₦40,000	10	8.3
Number of years in Business		
Less down 2years	19	15.8
2-4years	44	36.7
5-6years	27	22.5
7-8years	19	15.8
Above 8years	11	9.2
Motorcycle Ownership		
Owned by rider	110	91.7
Not owned by rider	10	8.3
Other Vocational Activities		
Yes	69	57.5
No	51	42.5

****** Note: exchange rate at ₦311.9 to US $1 as at the time of survey in July, 2017

Table 1 further show that a large majority (74.2%) of the respondents have more than two years riding experience, while 9.2% have been in the business for more than eight years. Furthermore 57.5% of the motorcyclists have some vocational training but have abandon such occupation for commercial motorcycling because it yields better financial returns. The implication is that farming and many other occupations such as motor mechanical works, electrical works, bricklaying and carpentry have been losing trained labour to commercial motorcycle operation in the country with great negative repercussions for the economy.

Prevalence of Crash Helmet Usage among Commercial Motorcyclists in Ilorin

In order to establish the rate of adoption of crash helmet among the motorcyclists, the regularity of use, reasons for usage or non-usage and respondents' opinion on whether the use of helmet should be made optional where examined. Results show that most (81.6%) of the commercial motorcyclists possess crash helmet (table 2). It was however discovered that the high rate of ownership of crash helmet does not indicate adherence to the helmet law by the riders. Examination of the frequency of usage of helmet showed that 15% of the respondents agreed that they only wear head helmet on rare occasions. However, 45.8% of the respondents used helmet most of the time.

Table 2. Prevalence of crash helmet usage among the riders
(Source: Field Survey, 2017)

Variables	Frequency	%
Possession of helmet		
Yes	98	81.6
No	22	18.4
Total	120	100
Frequency of helmet use		
Rarely	18	15.0
Sometimes	30	25.0
Most of the time	55	45.8
Always	17	14.2
Main reason for helmet usage		
It is just a habit	21	17.5
To obey the law	29	24.2
To avoid being fined/punished	51	42.5
Because of its safety implications	19	15.8

As also seen in table 2, only 14.2% of the respondents put on helmet at all times when riding their motorcycles. Since crash helmets are supposed to be used at all times when motorcycles are being operated, it could be seen that adherence to this traffic regulation is very low. In a situation where only 14.2% fully abide by this regulation, it implies that there is still a long way to go in terms of enforcing this regulation in the area. This result is in line with the findings of some other previous studies that have also shown that rate of adherence to the helmet law is low among motorcyclists in Nigeria (Olakulehin et al., 2015; Oyelade et al., 2015). Furthermore, it is common practice among commercial motorcyclists in the area, to put on helmet only when police or other traffic officials are sighted and the helmet is immediately removed again when the officers are out of sight. For those who do not possess helmet at all it is usual for such riders to completely avoid routes where they are likely to come across traffic officials (figures 2 and 3).

Figure 2. A Commercial motorcyclist without helmet in Ilorin
Source: Authors, 2017

Figure 3. Helmeted motorcyclists with unhelmet passengers
Source: Authors, 2017

Reasons for the Use of Helmet by Commercial Motorcyclists in Ilorin

In order to better understand the factors influencing adherence to the helmet law among the motorcyclists, the study also examined their main reasons for the use of crash helmet. The results show that a significant proportion (42.5%) of the motorcyclist's wear helmet in order to avoid facing the wrath of the law in form of fines or even imprisonment (table 2). Another 24.2% do so just to obey the law without really being interested in why its usage is important. Table 2 further shows that only 15.8% of the motorcyclists use helmet because of its safety implications and that it may save them from serious injuries or even death in case of accident. This implies that most of the riders are not mindful the safety benefits of crash helmet; rather they see it is a burden that must be borne to avoid altercation with the law. Such is the situation that cases have been recorded of motorcyclists who wear painted dried shells of pumpkin fruits (calabash), pots and pans as helmet to beat the law (Oboh, 2009). Many others obtain inferior plastic helmets that would break into pieces on impact when crashes occur. This shows that most of the motorcyclists do not attach much importance to the wearing of crash helmet, which justifies the need for proper enlightenment to change the orientation of the riders.

Commercial Motorcyclists' Opinion on Enforcement of Helmet Use

A major proportion (90%) of the riders wants the use of crash helmet to be made optional rather than being compulsory. Among this group, 75.8% are strongly in support of its being made optional as shown in table 3.

Table 3. Respondents' opinion on enforcement of helmet use
(Source: Field Survey, 2017)

Whether helmet use be made optional	**Frequency**	**Percent**
Strongly agree	91	75.8
Agree	17	14.2
Disagree	07	5.8
Strongly disagree	05	4.2
Total	120	100

It implies that most of the riders view the regulation on use of crash helmet as an unnecessary imposition. This is not surprising because public apathy to traffic safety regulations is a common phenomenon in the country (Gbadamosi, 2006; Tunde et al., 2012). For instance, many

motorists in Nigeria view traffic regulations such as the use of seat belt and avoidance of use of cell phones while driving among others as unnecessary. Some even believe that all accidents and the results of such accidents are ordained to happen, so preventive actions cannot change what will happen. Evidence therefore abounds about people who believe in the efficacy of charms or some supernatural power that would protect them in case of accident (Iweze, 2011; Olusayo, et al., 2015). For example, Olusayo et al., 2015 found that many commercial motorcyclists in Ogbomoso, Oyo State Nigeria, believed that they are immune to road traffic injury by relying on the efficacy of prayers or charms.

Awareness of the Importance of Crash Helmet among the Riders

The level of awareness of the motorcyclists on the importance of crash helmet was also examined. This was done by rating their views on the role of crash helmet in preventing head injury, the need to continue enforcement of helmet use, whether the use of helmet is necessary and whether non-use of helmet should attract greater penalty. As shown in table 4, majority (62%) of the motorcyclists agreed that helmet can prevent head injury though only 8.3% strongly agreed with this view. However, 60.9% of the riders are against the enforcement of helmet usage while only 8.3% of the operators believe that breaking of the helmet law should attract greater penalty. Table 4 further show that only 37.5% of the riders agreed that helmet should always be worn while riding.

Table 4. Level of awareness of the riders on the importance of crash helmet
(Source: Field Survey, 2017)

Variables	Strongly agree (%)	Agree (%)	I don' t know (%)	Disagree (%)	Strongly disagree (%)	Total %	Mean Score ++
Helmet prevents head injury	8.3	54.2	8.3	20.0	9.2	100	3.32
Government should continue to enforce helmet usage	8.3	30.8	0	49.2	11.7	100	2.74
Helmet should always be used while riding	0	37.5	0	38.3	24.2	100	2.50
Helmet must always be correctly buckled when worn	12.5	14.2		54.2	19.1	100	2.47
Non-usage of helmet should attract greater penalty	0	0	0	62.5	37.5	100	1.62
Helmet usage is important	36.6	35.8	0	27.5	0	100	3.81
Total (Average %)	11.0	28.8	1.4	41.9	16.9	100	2.75

Note: Strongly agreed (5), Agreed (4), I don't know (3), Disagree (2) Strongly disagree (1)
++ Maximum mean score = 5.0

Furthermore, as seen in table 4 only 12.5% of the operators strongly agreed that helmet should always be properly buckled when used while 73.3% are in disagreement with this idea. In addition, a large majority (72.4%) of the riders accept that the usage of crash helmet is important. These results indicate that the riders are largely aware of the important protection crash helmets could provide in case of accident but most of them are just averse to its use. For instance, the high

mean scores of 3.81 and 3.32 for 'helmet usage is important' and 'helmet prevents head injury' respectively, is a clear indication that the respondents are aware of the significance of the protective role of crash helmets. However, this antipathy for helmet use may be the result of the general low compliance with road safety regulations by road users, particularly commercial motorcyclists in Nigeria (Adisa, 2010; Johnson and Adebayo, 2011; Tunde et al., 2012; Olusayo et al., 2015; Oyelade et al., 2015). Furthermore, reluctance to properly buckle helmet while in use is also an indication of aversion to the use of helmet by the riders, which greatly reduces the effectiveness of crash helmet in case of accident. When not properly buckled there is much likelihood that the helmet will fall off during a crash thereby exposing the rider's head to injury.

CONCLUSION

Conclusively, this study has shown that the rate of use of helmet among commercial motorcyclist is low in Ilorin. This is a further confirmation of the poor level of adherence to the helmet law in Nigeria. Reluctance of commercial motorcyclist to use helmet even when it is known to be beneficial, in conjunction with poor level of enforcement have continued to be responsible for low level of compliance with the helmet law in Nigeria.

It is therefore recommended that greater efforts should be directed towards public enlightenment on the importance of helmet usage particularly its role in preventing head injury in case of accident. Agencies such as the Federal Road Safety Commission (FRSC), the National Orientation Agency (NOA), Ministries of Health at federal and state levels and None Governmental Agencies (NGOs) in conjunction with the riders' associations should be fully involved in this effort.

Furthermore, there is the need for proper enforcement of the helmet law. The law should be fully implemented to ensure that all riders wear crash helmets at all the times, when operating motorcycles. Appropriate punishments including fines and even imprisonment should also be applied to ensure enforcement. This could be made more effective through the use of mobile courts for quick dispensation of justice.

In addition, appropriate mechanisms should be put in place for a gradual phasing out of the use of motorcycles for commercial transport services particularly in urban areas. If mass transit services could not be adequately introduced, motorcycles should be replaced with tricycles which are comparatively safer while also providing services in areas not easily served by four wheeled vehicles.

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THE IMPACT OF SOCIO-ECONOMIC ACTIVITIES ON ATMOSPHERIC AIR IN THE SOUTH REGION OF THE REPUBLIC OF MOLDOVA

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Abstract: The purpose of this research consists in the elucidation of spatial and branch aspects of the impact of pollution sources on the atmospheric air in the Southern Region of the Republic of Moldova. The main topics presented in this paper are: 1) the dynamics of emissions from fixed and mobile pollution sources; 2) spatial and branch profile of emissions generated by fixed pollution sources: 3) existing problems in evaluation and monitoring of emissions sources; 4) the implementation of objectives on adaptation to climate change and low emission economy. The volume of emissions from fixed sources is conditioned by the size of districts and of their urban centers, by the number and capacities of sources from energetics, agri-food complex and fuel stations, and by level of emissions monitoring of environmental authorities. In the majority districts and economic activities is found a oscillatory dynamics of emissions, on the background of a general growth trend.

Key words: impact, emissions, region, dynamics, mobile sources, fixed sources

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INTRODUCTION

The Southern Region occupies an area of 9.2 thousand km² or more than ¼ of the total area of the Republic of Moldova. The population of the region is ≈700 thousand inhabitants or 17% of the total population of the Republic. Within the Southern Region are delimited two development regions: 1) The South Development Region, which comprises 8 districts with a total area of 7.4 thousand km² (22%) and about 530 thousand inhabitants (13%); 2) The Gagauz Development Region, with the area of 1.8 thousand km² (5.5%) and ≈170 thousand inhabitants (4.0%). Urban populations account for less than 20% of the total population. Therefore, compared to the other regions of the Republic (Bacal and Sterpu, 2019 a, b), the South Region

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has a much lower level of urbanization and industrialization, which conditions a lesser anthropogenic impact on atmospheric air, water resources, on other natural components and the human body. At the same time, the Southern Region is crossed by international and national roads with intense traffic, and the degree of afforestation of the territory is lower than the rest of the regions. In addition, in the proximity of the South Region there are very high sources of pollution, such as the Dnestrovsk Thermoelectric Plant from left bank of Dniester river and the metallurgical plant form Galati, which significantly affect air quality in the study region.

The territory of the Republic of Moldova is extremely vulnerable to the current climate change, which is manifested by the increasing contribution of the anthropic factor. Therefore, reduction and efficiently control of emission has become a key imperative of international politics, stipulated in national strategic documents (Nielsen, 2013; GD no. 1740, 2016; GD no. 1009, 2014; GD no. 301, 2014), in international conventions and agreements on sustainable development and environmental protection (Brega & Tărîță, 2019). Therefore, studies in the field of assessment and management of emissions of indigenous sources of atmospheric air pollution have not only a theoretical importance, but also a great applicative significance.

Under Objective 7 of the National Environmental Strategy (2014-2023) (GD no. 301, 2014), in the field of atmospheric air protection is planned the achieving of two directions of actions: 1) creating of integrated management system of air quality; 2) reduction of pollutant emissions into the atmosphere by 30% until 2023, and of greenhouse gases by 20% until 2020, compared to 1990. The main measures planned under the first action are: 1) creating the register of emissions and of pollutants transfers and its inclusion in the integrated environmental information system; 2) elaboration of the mechanism, methodology and instruments for determination of pollutant emission limit values in accordance with local conditions and industrial capacity; 3) optimization of the control system of air quality; 4) creating a national emissions inventory system and setting of national emission ceilings; 5) the introduction of new ecological standards for vehicle emission and fuel quality.

Also, Objective 2 of the National Strategy on Adaptation to Climate Change provides creation and operation of the National Monitoring and Reporting System of Greenhouse Gas Emissions (GD no. 1009, 2014), the adjustment of the existing national methodology (Methodology for calculating concentrations of toxic substances in the atmospheric air from enterprises, 1987) to the European Emissions Assessment Methodology (Nielsen, 2013).

The Low Emissions Development Strategy of the Republic of Moldova (GD no. 1740, 2016) provides the unconditional, until 2030, of the total national emissions of net greenhouse gases, with not less than 64%, compared to 1990 level, in support of the global effort to maintain the overall global warming trend. The overall objective will be achieved by reducing greenhouse gas emissions in the energetics, transport, agriculture, households, industry, forestry and waste.

MATERIAL AND METHODS

In this study are included the absolute majority of enterprises and public institutions, the volume of which is about 90% of the total emissions of fixed sources, with the exception of emissions from communal waste landfills and of emissions from households.

For achieving of the present study have been applied the following research methods: analysis and synthesis, statistical, mathematical, analogical, normative and sociological. Statistical and mathematical methods were used to process statistical data on the volume and toxicological composition of emissions, depending on their branch profile. The analysis and synthesis method were used to identify problematic situations, elaborating of conclusions and recommendations for optimizing the management of emission sources. The sociological method was applied to the consulting of environmental authorities, to interviewing of selected companies in the Southern Region of the Republic of Moldova. The analysed period includes, mostly, the years 2004-2018.

The main information sources were: Yearbooks of the State Environmental Inspectorate "Environmental Protection in the Republic of Moldova" (2004-2008); Yearbooks of Environmental Agencies and Inspections (2004-2018); National Bureau of Statistics (NBS) reports on atmospheric air protection (2007-2016); National reports on the inventory of greenhouse gases (2017); national strategies in the field (GD no. 1740, 2016; GD no. 1009, 2014; GD no. 301, 2014); methodological guidelines for the assessment and reporting of emissions (Nielsen, 2013; National reports on the inventory of greenhouse gases, 2017; Methodology for calculating concentrations of toxic substances in the atmospheric air from enterprises, 1987). Recent bibliography on national and regional air pollution (Bacal, 2010; Bacal and Sterpu, 2019a, b; Brega & Tărîță, 2019; Comisia Economică pentru Europa, 2005).

RESULTS AND DISCUSSIONS

Emissions of mobile sources

Atmospheric air quality is conditioned by the heavy traffic flow, from which comes about 90% of the total volume of emissions in the South Region (table 1). The volume of emissions of mobile sources is conditioned by the configuration of the road network and by the intensity of car traffic, as well as by the amount of delivered fuel in the districts and cities of the region. Therefore, the maximum volume of emissions from car transport is attested in the ATU (Autonomous Territorial Unit) of Gagauzia (6.0 thousand tonnes/year), in the districts of Cahul (7.6 thousand t/year), Cimislia (2.7 thousand t/year) and Căuşeni (2.4 thousand t/year) (Environmental Protection in the Republic of Moldova, 2004-2008), and the minimum volume – in the smaller districts such as Basarabeasca (449 t/year), Taraclia and Cantemir (1.2 thousand tons/year for each). On the whole, the volume of emissions from mobile sources registered an oscillating evolution, on the background of a general positive dynamics (+ 45%), which is observed in most districts of the region. The maximum increase is recorded in the districts of Taraclia (7.6 times) and Cahul (3.3 times), which is conditioned by the construction of the new fuel stations and the multiple increase of the volume of delivered fuel in these districts. In addition, the multiple increase of emissions from mobile sources in the Cahul district is largely due to the small border traffic achieved through the two access ways to Romania (Cahul/Oancea and Giurgiulești/Galați).

The predominance of old cars and the low quality of the used fuel contribute to the air quality reduction in the study region. In urban centers there are significant overruns of admissible concentrations in the perimeter of the overcrowded traffic arteries in the central part of the respective localities (Bacal, 2010, p. 56).

Table 1. The dynamics of volume of emissions generated by mobile sources in the South Region. in tonnes
Data source: Environmental Protection in the Republic of Moldova, 2004-2008

No.	Districts	Years												ave-rage	Growth, %	Share, %
		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018			
1	Căușeni	2650	1600	2061	2416	2197	2591	2591	2697	2110	2848	2221	3220	*2362*	121	82
2	Ștefan-Vodă	1851	1791	1549	2127	1117	2100	2102	4485	2871	2871	2211	2144	*2279*	116	85
3	Cimișlia	2622	2400	2849	3487	3231	3082	2539	2516	2204	2302	2135	2298	*2670*	88	81
4	Basarabeasca	686	353	359	369	369	469	469	469	464	464	469	469	*449*	68	80
5	Leova	4479	1325	1431	1299	1258	1147	1293	1187	1318	1326	1523	1287	*1599*	29	83
6	Cantemir	1072	857	1520	1354	377	1421	1721	1236	1356	1356	1344	1367	*1238*	128	86
7	Cahul	5910	6329	17064	8392	6005	5863	5491	5927	7234	7234	6792	19349	*7476*	327	98
8	Taraclia	218	422	1218	1277	1427	1451	1491	1447	1298	1687	1757	1663	*1245*	763	86
9	UTA Găgăuzia	5587	5398	6602	5702	5858	6172	13857	4514	4990	2756	4990	4508	*6039*	81	89
	Southern Region	**25075**	**20475**	**34653**	**26424**	**21840**	**24295**	**31553**	**24477**	**23844**	**22843**	**23442**	**36304**	***25356***	**145**	**91**

Emissions of stationary sources

Evidence of stationary source of emissions

Most fixed emission sources (628 or 37%) are from the agro-food complex (c.) (table 2), of which predominates the small and medium-sized production units, such as mills, flats and bakeries, public catering enterprises (bars, cafes) predominantly located in rural areas. Also, in the South Region, there are more than 80 wineries, which are a major source of pollution both for air and for water (Environmental Agencies and Inspections, 2004-2018). The absolute majority of medium and large capacity enterprises are located in urban areas, especially in the cities of Cahul, Causeni and Comrat. Poultry factories, slaughterhouses and sausage production enterprises, farms for the cultivation of vegetables and flowers are concentrated in the proximity to the district centers or inside of them. Oils, dairy and cereal production plants are less widespread than northern and central districts (Bacal and Sterpu, 2019 a, b). The maximum number of agro-food enterprises is also registered in ATU Gagauzia (92), in the districts of Leova (165) and Causeni (93).

Table 2. Branch structure and spatial distribution of fixed emission sources in the Southern Region
Data sources: Annual Reports (2004-2018) of Environmental Agencies and Inspections

No.	Districts	agri-food c.	wine-ries	ener-getics	fuel trade	tran-sports	ser-vice	MI BM	wood-working	light ind.	comm unal s.	M MW	chemi-cal ind.	total
1	Căuşeni	93	6	64	25	18	13	10	1		2			**226**
2	Ştefan Vodă	37	6	49	19	3		2			1			**111**
3	Cimişlia	23	4	47	28	13	6	11		1				**129**
4	Basarabeasca	45	5	22	5	14	8	5	4	4	3	1	1	**112**
5	Cantemir	56	10	46	9	6	9	3				1		**130**
6	Leova	165	10	93	22	13	58	16	5	1	2	2	3	**380**
7	Cahul	60	13	25	17	11	12	27	6	4	2		2	**166**
8	Taraclia	57	11	67	15	31	7		3	1	3	1	1	**186**
9	ATU Gagauzia	92	19	40	70	22	12	12	4	11	1	7		**271**
	Southern Region	**628**	**84**	**453**	**210**	**131**	**125**	**86**	**23**	**22**	**14**	**12**	**7**	**1711**

On the second position, with 453 units or 26%, is situated the energetics, most of which are thermal plants (boiler rooms) of the mayoralties, educational and medical institutions. The number of sources in the thermo-energetics complex is not only conditioned by the number and size of urban and rural localities, by their thermal energy consumption, by the number of existing public institutions, but and by the level of evidence of the respective sources of emissions. Thus, the maximum number of the emissions sources from energetics is recorded in the districts of Leova (86), Taraclia (67) and Causeni (64). In the last decade, there has been a significant increase of the number and of capacity of thermal plants based on biomass and volume of emissions from these sources, which have a lowest toxicity level than emissions from combustion of fossil fuels. The absolute majority of the biomass-based thermal plants operates at the educational institutions (Environmental Protection in the Republic of Moldova, 2004-2008; Environmental Agencies and Inspections, 2004-2018). In the South Region, there are 80 biomass-based thermal plants that generate over 250 tons of emissions. Most of these plants are located in the districts of Leova (24), Căuşeni (16), Ştefan Vodă (15) and Taraclia (14), and the maximum volume of emissions from these plants is also recorded in districts of Ştefan Vodă (83 t), Căuşeni (62 t), Taraclia (30 t), Cimişlia (26 t) and Leova (25 t).

Fifth place is the fuel trading companies, with 210 units or 12%, which is far less than the central and northern districts (Bacal and Sterpu, 2019 a, b). The most fuel delivery and storage stations are attested in the ATU Gagauzia (70) and in the districts of Cimislia (28) and Căuşeni (25), which are intersected by roads with more intense traffic. On the fourth place is situated the transport enterprises, with 131 units (7.7%). In this category were attributed, not only automobile parks and companies of Moldovan Railways, but also car parks, technical service stations of the means of transport. The following position is occupied by service enterprises with

125 units (table 2) or 7.3%, most of which are commercial and service centers with a significant presence in the territory (Environmental Agencies and Inspections, 2004-2018). Most service enterprises are located in Leova district (58), where most of the smaller and medium-sized pollution sources have been taken into account.

In the mining and industry of building materials (MIBM) were identified only 86 units (5.0%), which is much smaller than the central or northern districts (Bacal and Sterpu, 2019 a, b), in which there are much richer raw materials compared to the South Region. The maximum number of enterprises in this branch is recorded in the Cahul district (25) and is due to the larger dimensions of the Cahul city. At the same time, small enterprises are involved in the production of pressed bricks and paving slabs. The number of enterprises in the other branches does not exceed 1.5% and is located almost exclusively in the district's centers of the region.

Space and branch analysis of fixed sources of air pollution

The volume of emissions, which is indicated in the annual reports of statistical and ecological authorities is conditioned by both the level of urbanization and industrialization of the region and the by the evidence and monitoring of atmospheric air pollution sources (Comisia Economică pentru Europa, 2005; Environmental Agencies and Inspections, 2004-2018). At the absolute majority of emission sources, the total volume and the main toxic substances are only estimated, based on the calculation methodology, which are applied since the Soviet period (Methodology for calculating concentrations of toxic substances in the atmospheric air from enterprises, 1987), depending on the type and amount of fuel used and, on the emission, and purification technology. In addition, are not subject to assessment the absolute majority of emissions from communal landfills and animal manure, emissions from households and from small and medium-sized enterprises and organizations. The main causes of this situation are: superficial control of pollution sources; the low number of qualified staff and their huge workload; lack of measurement devices.

After a massive decline in the 1990s, the sum of emissions from fixed sources recorded an oscillating dynamic on the back of a slower growth than mobile emissions (Environmental Protection in the Republic of Moldova, 2004-2008; Environmental Agencies and Inspections, 2004-2018; National reports on the inventory of greenhouse gases, 2017; National Bureau of Statistics (NBS) reports on atmospheric air protection (2007-2016). Also, stationary sources generate only 10% of total emissions of pollution sources in the region.

According to the Yearbooks of the State Ecological Inspectorate (Environmental Protection in the Republic of Moldova, 2004-2008; Environmental Agencies and Inspections, 2004-2018), in the period of 2004-2018 years, the total volume of emissions of fixed sources of pollution was on average 2.9 thousand tons and in 2018 - 3.5 thousand tons (table 3). Thus, the amount of emissions generated by stationary sources of pollution in the southern region of the Republic is much lower than the amount of emissions in the northern and central regions, which are larger, but also a higher level of urbanization and industrialization than the South Region. Overall, there is an oscillating evolution of the volume of emissions, conditioned by both the economic fluctuations and the degree of monitoring of the fixed emission sources by the territorial ecological authorities (Bacal, 2010, p. 56). Thus, during the period of general economic growth (2001-2009), there is a significant positive dynamic of the total volume of emissions. Subsequently, as a result of the economic recession, there is a slow negative dynamic, followed by a significant increase in the years 2017-2018, which is mainly due to the increase of evidence and control level of local pollution sources. The positive dynamics of total emissions is recorded in most districts of the region. A multiple increase in emissions is recorded in the districts of Cantemir (4.4 times), Căușeni (3.4 times), Cimișlia (2.3 times) and ATU Gagauzia (2.5 times). At the same time, in the Leova and Basarabeasca districts, there is a reduction of about 2.5 times of the total volume of emissions. At the same time, in the Leova and Basarabeasca districts, the total emission volume has been reduced by about 2.5 times.

The volume of emissions of fixed sources is conditioned by the size of their districts and urban centers, by the number and capacities of emission sources from the energetics, from the agro-food complex and fuel stations, and by the monitoring level of emission sources by the environmental authorities. Therefore, the maximum volume of emissions is found in districts of Causeni (516 t), Leova (447 t), Cahul (415 t) and in the ATU Gagauzia (405 t). The minimum volume of emissions is found in the Cantemir (156 t), Basarabeasca (186 t) and Taraclia (198 t) districts with lower dimensions and lower industrialization.

Table 3. The dynamics of emissions volume generated by fixed sources from South Region, in tons
Data sources: Annual Reports (2004-2018) of Environmental Agencies and Inspections; National Bureau of Statistics (NBS). Annual Reports (2004-2018) on atmospheric air protection

No.	Districts	Years															average	Growth, %
		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018		
1	Căuşeni	203	342	342	589	499	806	716	500	490	477	520	493	507	558	698	*516*	*344*
2	Ştefan-Vodă	443	401	455	343	252	199	199	214	228	213	279	342	373	333	368	*310*	*83*
3	Cimişlia	237	209	240	248	243	400	277	285	238	206	269	251	252	293	554	*280*	*234*
4	Basarabeasca	298	264	157	164	345	270	147	141	141	150	185	180	117	117	117	*186*	*39*
5	Leova	624	690	490	457	432	912	405	395	378	306	338	319	294	400	267	*447*	*43*
6	Cantemir	52	63	62	65	72	236	203	230	203	165	207	187	184	189	227	*156*	*437*
7	Cahul	271	307	264	275	474	532	519	513	518	757	426	382	291	288	407	*415*	*150*
8	Taraclia	180	181	205	197	187	160	167	187	161	162	183	210	285	243	264	*198*	*147*
9	ATU Găgăuzia	230	227	234	385	319	287,2	336	503	407	473	481	595	450	573	575	*405*	*250*
	Southern Region	**2538**	**2684**	**2449**	**2723**	**2823**	**3802**	**2969**	**2968**	**2763**	**2910**	**2888**	**2958**	**2752**	**2992**	**3478**	***2913***	***137***

In most branches of the economy there is an oscillating evolution of the total volume of emissions from the stationary sources of the region (table 4). A multiple increase of emissions is registered in the communal sector (13 times), service centers (8.4 times), fuel stations (4.2 times), woodworking enterprises (3.4 times) and in machinery and metalworking (M MW) companies − (2.5 times). The insignificant increase of emissions is observed in thermo-energetics and in the agro-food complex. The multiple increase of the volume of emissions from the communal sector is due exclusively to the municipal enterprise from Cahul city, which also assessed the emissions from landfills. A considerable reduction of emissions is recorded in the mining an industry of building materials (-22%), in the chemical industry (-19%) and in the light industry (-14%). In the wine industry, there is a 2.5 times reduction of emissions, which is caused both by the decline of this industry as a result of the blockage on the part of Russia and by the modernization of more competitive wineries.

Table 4. The dynamics of the emissions volume by main economic activities in the Southern Region, in tons
Data source: Environmental Agencies and Inspections, 2004-2018

Economic branch	Years															average	Growth, %
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018		
Energetics	1130	593,7	1094	983	1003	1507	1363	1128	1018	924	1004	1022	1012	1106	1323	*1081*	117
Agri-food complex	746,3	347,1	614,2	526	523	627	561	704	664	523	650	665	720	750	846	*631*	113
Fuel trade	190	197	277	454	335	360	369	492	376	396	415	507	531	659	793	*423*	418
Communal sector	9,7	0,2	10,4	7,2	284	330	329	334	338	255	242	148	144	139	126	*180*	1303
Transports	92,6	5,7	56,1	47	49	56	72	91	103	90	94	106	114	125	139	*82,6*	150
MIBM	121,6	67,9	122	122	71	56	50	56	48,68	60	65	68	90	71	94	*77,6*	78
Service	11,5	4,5	8,0	14	16	18	18	30	34	52	55	61	63	*76*	*96*	*37,1*	838
Woodworking	10,5	1,9	22,5	19,2	45,7	29,5	28,3	39,7	38,2	36,9	37,9	37,8	38,2	39,4	35,6	*30,7*	340
Light industry	12,1	3,0	8,9	8,4	10,5	11,9	9,0	8,4	8,2	9,0	7,6	6,9	7,4	8,0	10	*8,6*	86
Machinery and metal-working	4,2	0,2	1,3	4,2	4,3	4,2	3,7	3,7	3,7	0,3	4,0	4,1	4,1	10,5	10,6	*4,2*	253
Chemical industry	2,3		2,2	1,8	1,9	2,5	2,3	2,5	2,3	1,5	1,1	1,9	1,9	1,9	1,9	*1,9*	81
Total	**2331**	**1221**	**2216**	**2186**	**2343**	**3003**	**2806**	**2889**	**2635**	**2348**	**2575**	**2628**	**2726**	**2987**	**3476**	**2558**	**149**
Wineries	268	91	201	172	163	121	106	178	183	69	84	85	101	97	103	135	39

In the branch structure of emissions of fixed sources, the first positions are occupied by energy (42%), the agro-food complex (25%) and the fuel trading stations (17%), which generate 85% of total volume of emissions (figures 1 - 2). The following positions are occupied by communal sector (7%), transport (3%) and companies for production of building materials (3%). The share of other branches is ≤1%.

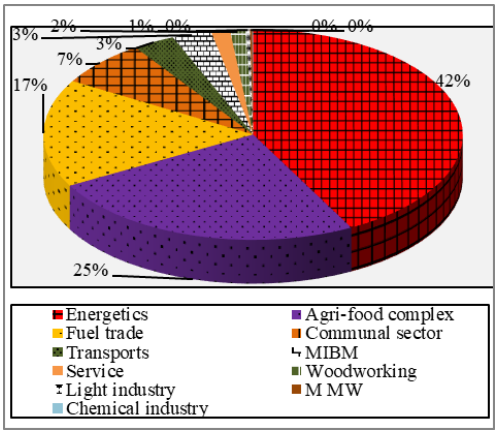

Figure 1. Branch structure of emissions from fixed sources (average of 2004-2018 years)

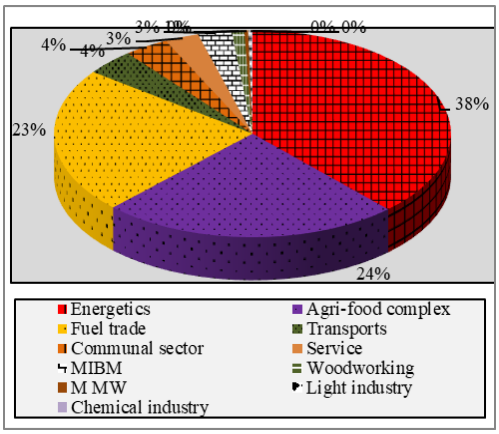

Figure 2. Branch structure of emissions from fixed sources (2018 year)

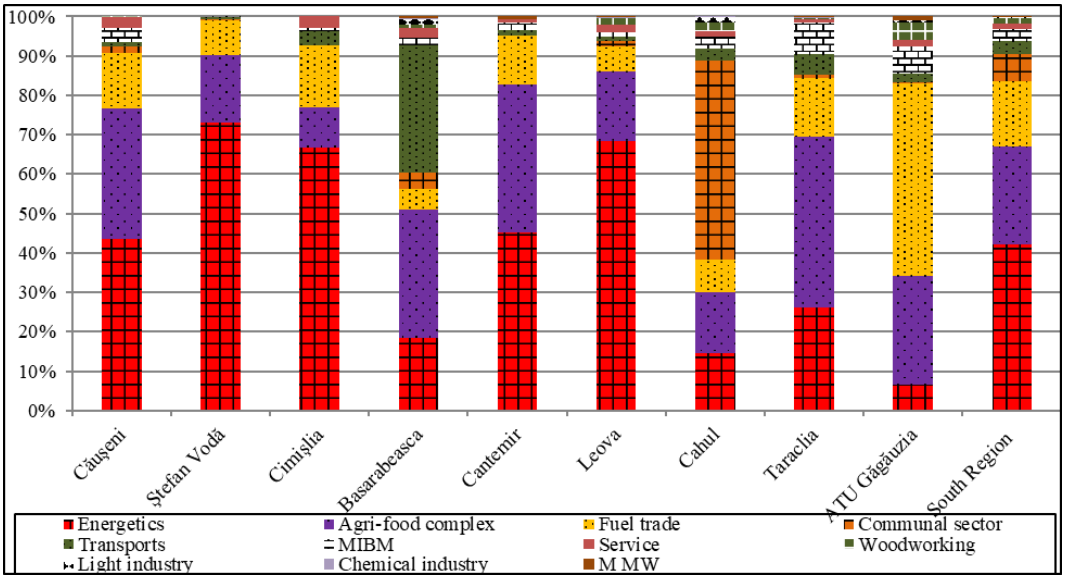

Figure 3. Branch structure of emissions from stationary sources in the districts of South Region (average 2004-2018)
Data source: Environmental Agencies and Inspections, 2004-2018

From energetics are discharged, on average, 42% (1.1 thousand tons) of emissions from fixed sources (figures 1-2). The volume of emissions and the share of energetics are conditioned by the number and capacities of the thermal plants of administrative, educational and medical institutions, which have provided information on emissions (Environmental Agencies and Inspections, 2004-2018). Thus, a maximum share of over 60% is attested in the Ștefan-Vodă,

Cimişlia and Leova districts (figures 3-4). An average share is found in the Causeni and Cantemir districts, and a reduced share (<20%) − in the Basarabeasca, Cahul and Taraclia districts. The maximum volume of emissions from energetics is recorded in the districts of Leova (274 t), Causeni (211 t) and the minimum − in the districts of Basarabeasca (20 t), Taraclia (52 t), Cahul (51 t), where the most public institutions did not reported information about emissions (Environmental Agencies and Inspections, 2004-2018).

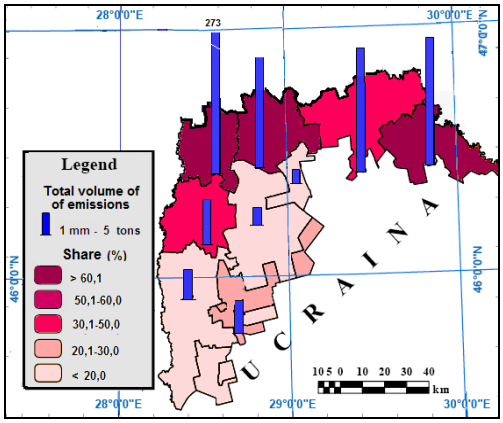

Figure 4. The volume of emissions and the share of energetics in the branch structures of fixed sources in the South Region

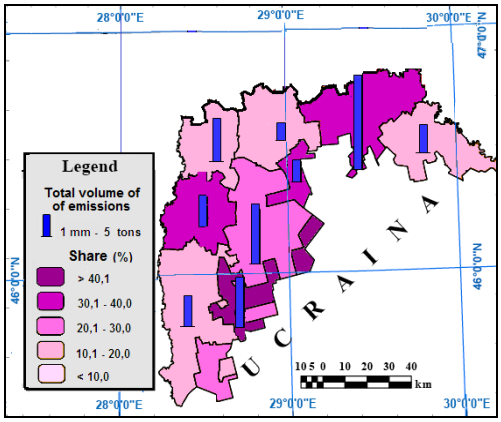

Figure 5. The volume of emissions and the share of agro food complex in the branch structures of fixed sources in the South Region

The agro-food complex is on the second position with, an average, of 630 tons, and in 2018 year − 846 tons of emissions or about ¼ of the total volume of fixed-source emissions from South Region. Agro-food companies have a more balanced share, being distributed relatively uniformly in the all districts of the region. In the Taraclia, Cantemir, Basarabeasca and Căuşeni districts, the agro-food complex's weight exceeds 30% of the total emissions from fixed sources of air pollution. The minimum (<15%) share of agro-food enterprises is observed in the Cahul, Leova and Cimislia districts (figures 3 - 5), which is explained by the absolute predominance of the energetics in the districts and of the communal sector in the Cahul district. In 2018, maximum volumes of emissions from the agro-food complex were discharged in in the ATU Gagauzia (138 t) and in the Causeni (217 t), Taraclia (90 t), Cahul (89 t) districts.

The biggest polluters from the agro-food complex are: wineries (135 t), including from ATU Găgăuzia (35 t)and from districts of Taraclia (26 t), Causeni (17 t), Leova (16 t), Stefan Vodă şi Cantemir (14 t each); cereal processing factories from Căuşeni (107 t), Cantemir (55 t), Taraclia (10 t), Iargara and Vulcăneşti; oil production plants from Căuşeni (22 t) and Vulcăneşti; big agricultural companies, especially from Causeni, Basarabeasca, Cantemir and Taraclia districts; poultry farms from Basarabeasca and Cimislia districts; canning factories from Ştefan-Voda (14 t), Căuşeni and Cantemir districts; bakery factories from district centers; mills, flats and bakeries from rural area; public catering enterprises (Environmental Agencies and Inspections, 2004-2018).

The total volume of emissions from fuel stations was, on average, 423 tons or 17% (figures 1-2), and in 2018 ≈800 tons or 23% of total emissions discharged from fixed sources of air pollution. During the analyzed period there is an increase of more than 4 times of the emissions from the respective branch. The biggest polluters are the gas distribution centers from the district centers; oil stores and fuel trade stations on national roads. Fuel stations have a uniform distribution, being concentrated in the range of urban centers and national routes (Bacal, 2010 p. 62). The maximum share (≈50%) of the fuel trading stations is attested in ATU

Gagauzia, and in the districts of the region, the share of the respective branch varies from 5% to 20% (figure 3). In 2018, the maximum emissions from the fuel stations are recorded in the ATU Gagauzia (316 t), as well as in Causeni (171 t), Cimislia (93 t) and Stefan Voda (82 t) districts.

The volume of emissions from communal sector was on average 180 tons or 7% of total volume of emission from stationary sources of air pollution and is due exclusively to the municipal enterprise in Cahul. In the other districts, the share of the communal sector does not exceed 2% and the volume of registered emissions − 10 tons, which is due to the massive absence of emissions data generated by this branch. At the same time, the harmful impact on the human body is strongly felt next to each treatment plant, and the damages caused to air and water is significant.

The volume of emissions generated by the transport companies is on average 83 tons or 3%, and in 2018 - 139 tons or 4% of total stationary source emissions from the South Region. The volume of emissions and the share of this branch are conditioned by the size and geographical location of the urban centers, by the number and capacity of the transport companies, and also by the degree of evidence of these emission sources by the environmental authorities. Thus, the maximum share of transports is attested in Basarabeasca district (30%), where is located an important railway hub. In most districts of the region there is a moderate share of transport companies (1-4%) (figure 3). The maximum volume of emissions from this branch is registered in the districts of Basarabeasca (35 t), Taraclia (22 t), Causeni (18 t), Cimislia (17 t) and Cahul (16 t).

From mining and industry of building materials (M BM) were discharged, on average, 78 tons and in 2018 - 96 tons of harmful emissions or only 3% of the total emissions from stationary sources, which is much less than the northern and central regions (Bacal and Sterpu, 2019 a, b). This is explained both by the much lower supply with raw materials for the building materials industry and by the exclusive presence of the small and medium-sized towns. A high share (≈10%) of M IBM is found in the Taraclia district, while in the rest of the districts, the share of this branch does not exceed 3%. The biggest polluters from the mining and industry of building materials are: building companies, enterprises for producing of pressed bricks and paving slabs, road reconstruction companies from Cahul, Causeni and Taraclia. Emissions from construction sites are estimated superficial, but their impact is harmful and occurs frequently.

Despite the relatively large number and relatively uniform distribution, the volume of emissions from service enterprises was on average only 37.1 tons or 2%, and in 2018 − 96 tons or 3% of total emissions from fixed sources of air pollution (figures 1-3). The amount of emissions and the share of this sector are conditioned by the number and capacity of the service and commercial centers from the region, but also on the level of monitoring of these sources by environmental authorities. The maximum volume of emissions is found in the Leova, Causeni and Cahul districts.

The volume of emissions from woodworking enterprises was, on average, 30.7 tons, and in 2018 − only 35.6 tons or only 1% of the total emissions from stationary sources. The reduced share of this branch is due both to the much lower afforestation compared to the central districts and to the exclusive presence of small and medium-sized towns in the South Region. Also, because of the low level of urbanization, there is a very low volume of emissions generated by enterprises from the machinery and metalworking industry (M MWI). In addition, most of companies from these branches are located in Cahul city, and in Comrat and Ceadâr Lunga towns from ATU Gagauzia.

CONCLUSIONS

Road transport generates about 90% of the total volume of emissions discharged in the South Region. The volume of emissions from mobile sources is conditioned by the configuration of the road network and the intensity of road traffic in the region's districts.

Most of the stationary emission sources are discharged from the agro-food complex (37%), the thermo-energetics complex (26%), the fuel station (12%), from the transport and the

service centers (7.3%). In the last decade, there has been a significant increase of number and capacity of the thermal plants based on biomass and volume of emissions from these sources, which have a lowest toxicity level than emissions from combustion of fossil fuels.

The volume of emissions from fixed sources registered an oscillating evolution on the background of a general trend of slow growth, which is observed in the most economic branches and of districts from the South Region.

In the branch structure of emissions from stationary sources of air pollution in the South Region, the first positions are occupied by the thermo-energetics and agro-food complexes, followed by the fuel stations. The superficial assessments of emission significantly reduce the management efficiency of impact on atmospheric air.

A major impact on atmospheric air is generated by biological wastewater treatment plants, but which episodically presents information on the amount and toxicity of pollutants discharged into the atmospheric air. At the same time, the harmful impact on the air and the human body is strongly felt in the proximity of majority treatment station.

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EVOLUTION OF POPULATION OF HUMAN SETTLEMENTS BETWEEN YEARS 1912 AND 2011 IN MEHEDINȚEAN DEPRESSION CORRIDOR AND SEVERIN DEPRESSION

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Abstract: Through the study on the two depressions in the northern half of Mehedinţi County, we aimed to highlight the main characteristics of population evolution between 1912 and 2011, using data provided by INS Mehedinţi and Geographical Dictionary of Mehedinţi County published in 2011, have demonstrated four major geodemographic trends: the population of the two depressions registered higher values of demographic growth compared to the situation in the entire county, due mainly to city Drobeta Turnu Severin; the existence of two periods of evolution, a positive one until 1992, followed by a demographic decline that is and currently felt; the deeply rural population in Mehedinian Depression Corridor is experiencing a severe demographic decline; the urban population and the urban agglomeration of the city that includes most of the Severin Depression was protected from depopulation recorded in rural areas.

Key words: demographic, decline, Drobeta Turnu Severin, Danube, urban, rural

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INTRODUCTION

Mehedinţean Depression Corridor and Severin Depression are located in the southwestern part of Romania, between the Coşuştei Hills in the east and the Mehedinţi Plateau to the west (Cucu and Cucu, 1980; Oglindoiu, 2010). In the south are bounded by the Danube River; The Bălciţei Piedmont, which together with the Coşuştei Hills and the two mehedinţi depressions are part of the Strehaia Piedmont which is a subdivision of the Getic Plateau and Flămânda Plain, a name given to the western part of the Blahniţa Plain, part of the Oltenia Plain, representing the western extremity of the Plain Romanian (Vîlcea, 2011; Badea and Dinu, 1974; Boengiu et al., 2012; Braghină, 2000). Within the Mehedinţi County, the two depressions are located on the surface of nine communes and the city of Drobeta Turnu Severin. The nine communes are from north to south: Bala, Şovarna, Ilovăţ, Sisesti, Malovăţ, Izvoru Bârzii, Brezniţa-Ocol, Şimian and Hinova (Ianoș and Iacob, 1980; Peptenatu, 2005).

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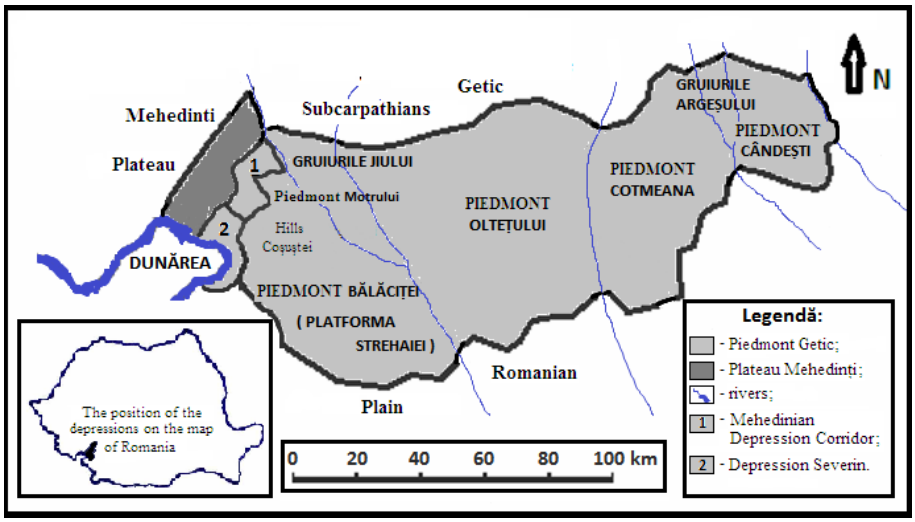

Figure 1. Mehedinţean Depression Corridor and Severin Depression within the Getic Plateau

For a clear understanding of the current demographic situation as well as the evolution over time, a comparison was made with the demographic situation of Mehedinţi County as a whole, thus arriving at new information that brings clarifications in the determination of the present state, highlighting both the rapid increases of the population as well as demographic decline, including in urban or rural areas.

Although there are well-known geographic works that analyze the demographic situation of Mehedinţi County as the works written by Vasile Cucu and Ana Popova Cucu in 1980 or the work written by Stroe Răsvan and Daniel Peptenatu in 2011, there are no extensive works to be carried out strictly on the depression area in the northern half of Mehedinţi County.

METHODOLOGY

The quantitative data were taken from the censuses of the population over the years from 1912 to 2011, provided by the County Mehedinti County Department of Statistics, but a special importance of the work published in 2011 by Razvan Stroe and Daniel Peptenatu: Geographic Dictionary of Mehedinţi County, which represents a wide demographic stigma on every locality or administrative area, with accurate and well documented data.

Through various mathematical and geographic calculations, the settlement of human settlements according to certain criteria, as well as the modeling of maps and sketches representative of the resulting data, or highlighted several trends that highlight two types of demographic evolution, one that is protected by the demographic decline specific to the city's surroundings Drobeta Turnu Severin, approaching the Danube, which includes much of the Depression of Sevrerin and one remote from the urban environment and the Danube River, which includes most of the Mehedinian Depression Corridor in a critical demographic decline.

RESULTS AND DISCUSSIONS

Evolution of the population of the two depressions compared to the demographic situation of Mehedinţi County

Mehedinian Depression Corridor and Severin Depression accommodate 47% of the entire population of Mehedinţi County, on an area of only 13% of the county. With a total population of 265,000 inhabitants in 2011, the number of inhabitants of the region is in a slight demographic decrease, lower than the decline registered at the county level, due to the evolution of the population in Drobeta Turnu Severin and the localities is located in its neighborhood.

Thanks to a sustained migration, originating in the plateau and plains areas which target the industrial area of Drobeta Turnu Severin, the population of the depressions held more and more percentages of the entire population of the county, which evolved from 44.7% in the year 1992 to 45.0% in 2002 and to 46.5% in 2011 (Peptenatu, 2005; Erdeli, 1998; Peptenatu and Braghină, 2006; Erdeli, 1983).

The total population of the two depressions increased steadily between 1912 and 1992, evolving from 60,000 inhabitants in 1912 to more than double, reaching the threshold of 150,000 inhabitants. After 1992, the population began to decline by losing to 10,000 inhabitants by 2002, followed by a decrease of 15,000 by 2011. In total there was a loss of 25,300 inhabitants in only 19 years, out of a total of 70,000 inhabitants as was the total demographic decline in the whole Mehedinti County in the same period.

Evolution of population on relief units

The dynamics of the population on the two relief units saw great differences between Severin Depression and Mehedinian Depression Corridor. If the population of the Depression of Severin was only three times larger than the population of the Mehedinian depression corridor at the level of 1912, until 2011 Depression Severin reaches 13 times the population.

Table 1. Evolution of the population on different categories in the Severin Depression and the Mehedinian Depression Corridor, between 1912 and 2011
(Source: Data processed by: Proiectul Universității București-1365, 2011; I.N.S. Mehedinți; Stroe and Peptenatu, 2011)

No.	Year / Category	1912	1992	2002	2011	Population evolution 1912-2011 (%)
1	Total population	60.502	148.834	137.939	123.483	+ 104
2	Urban population	25.463	115.259	104.557	92.608	+ 263
3	Only the city Drobeta Turnu Severin	23.463	108.204	96.859	84.867	+ 261
4	Rural population	35.039	33.575	33.379	30.875	- 12
5	Rural / total population Mehedințean Depression Corridor	15.765	10.860	10.526	9.034	- 43
6	Rural population Depression of Severin	19.274	22.715	22.853	21.841	+ 13
7	Total population Depression of Severin	44.734	137.974	127.413	114.449	+ 156
8	Degree of urbanization (%)	42,08	77,44	75,79	74,99	

The southern half of the Mehedinti depression, which is represented by the Severin Depression, registered a growth rate of the net population higher than the situation recorded in the north. Also, the population in the Mehedintian Depression Corridor declined to the level of 2011, only half of the population in 1912. In contrast, the Severin Depression experienced a demographic explosion at the same time, its population being 150% higher than he held in 1912. This means, on average, that the settlements halved their population in the Mehedintian Depression Corridor and rose once and a half in the Severin Depression at the same time. If by 1992 the population increased in the southern and urban areas and fell to the north, after this year the whole population decreased by 25,000 people. Of these, in the Mehedinian Depression Corridor, the loss was almost 2,000, and in the Depression of Severin the decrease was 23,000, more than 11 times the decrease in the northern half. In the Mehedinian Depression Corridor, on the surface of which there are four communes: Bala, Şovarna, Ilovăţ and Şişeşti, it was 100 years ago the double the population present, but the current censuses of the stable population included the inhabitants who have their domicile four communes, but they live and work in other areas such as Drobeta Turnu Severin, Timisoara, Motru or Bucharest, but also in Central-

Western Europe, which means that the actual population of the settlements was in 1912 maybe over three or more numerous than the population permanently living in this depression at present (Diaconescu and Lung, 2018; Peptenatu et al., 2012).

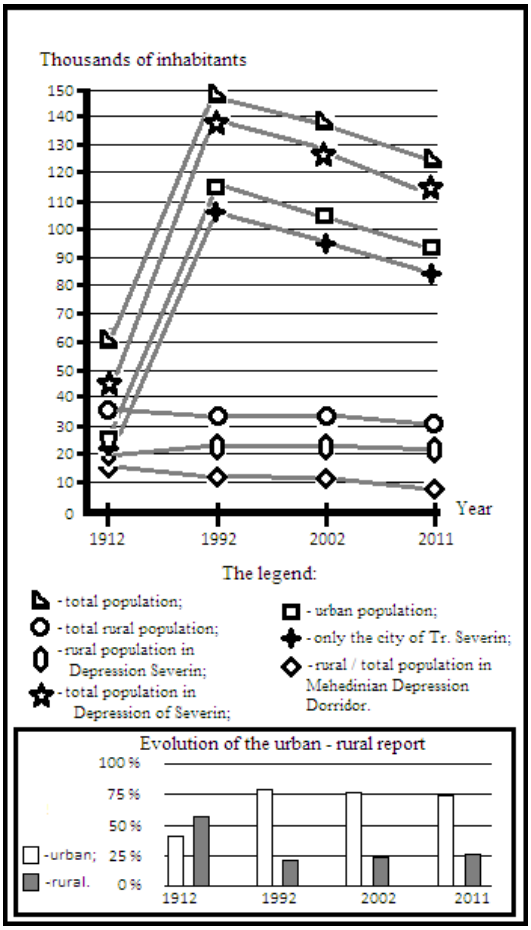

Figure 2. Variation in the number of populations by different categories and urban - rural ratio, between 1912 and 2011

(Source: Data processed by: Proiectul Universității București- 1365, 2011; I.N.S. Mehedinți; Stroe and Peptenatu, 2011; Stroe et al., 2008)

Evolution of the population by administrative units

The population of Mehedinti depression experienced a marked demographic increase until 1992, after which an ever more pronounced decline. However, the evolution of the population by administrative units reveals demographic features that are difficult to distinguish on a large scale.

At the level of 1912 the most populous commune was Bala with 6,000 people followed by Malovăț commune with 5,000 and Sisesti with almost 4,700 inhabitants, the other communes having less than 4,000 inhabitants (Erdeli and Gheorghe, 1979; Peptenatu, 2003). At that time, the nine communes owned 11,000 more people than Drobeta Turnu Severin. Until the year 1992, the most populated ones are: Șimian with 9,000 inhabitants, Bala commune with less than 5,000 inhabitants and Brezniţa Ocol commune with over 4,000 inhabitants. Communes in the Depression of Severin become more and more populated in relation to the settlements in the

Mehedinţean Depression Corridor, and the Municipality of Drobeta Turnu Severin reaches and even exceeds the population of the 9 communes with a total of 82,000 inhabitants. After 1992, the entire population of depressions declined steadily with a slight return due to migration from the adjacent relief units. At the level of the administrative units, four communes face a continuous demographic decline: Şovarna, Ilovăţ, Şişeşti and Malovat, three of which are located in the Mehedinti Depression Corridor. In only three administrative units, demographic growth is projected after 2011: Drobeta Turnu Severin and Hinova and Izvoru Bârzii communes. The commune of Bala registered an increase of the population between 1992 and 2002, and in the communes of Breznita-Ocol and Şimian, the population increased between 1992 and 2002 followed by a new period of growth after 2011. In the administrative units remote from the city of Dr. Tr. Severin, the population is in a vertiginous demographic decline, instead there is a stagnation and even a demographic increase in the town and the neighboring communes.

Table 2. Evolution of the population by administrative units between 1912 and 2017
(Source: I.N.S. Mehedinți; Stroe and Peptenatu, 2011; Ghinea, 2000; Diaconescu, 2013; Cucu et al., 1981)

No.	Unites Administrativ	1912	1992	2002	2011	2017 (estimate: 1 July)
1	Bala	5.773	4.682	4.759	3.963	3.714
2	Șovarna	2.523	1.532	1.415	1.270	1.091
3	Ilovăț	3.790	1.744	1.580	1.291	1.207
4	Șișești	4.681	3.469	3.210	2.959	2.583
5	Malovăț	5.350	3.261	3.005	2.780	2.605
6	Izvoru Bârzii	3.661	3.600	3.164	2.703	2.784
7	Brezniţa-Ocol	3.693	3.231	4.123	3.859	3.981
8	Șimian	3.732	8.714	9.670	9.650	10.316
9	Hinova	3.241	2.903	2.865	2.849	2.891
10	Total comune	36.444	33.136	33.796	31.324	31.171
11	Dr. Tr. Severin	25.463	115.259	104.557	92.617	108.063
12	Total	61.907	148.395	138.353	123.941	139.236

The population of the communes decreased between 1912 and 2017 with: 2,000 inhabitants in the commune of Bala, 1,500 inhabitants in the commune of Şovarna, 2,500 inhabitants in Ilovăţ commune, 2,100 inhabitants in the commune of Şeşesti, 2,700 inhabitants in the commune of Malovăţ, 1,000 inhabitants in the commune Izvoru Bârzii and 300 inhabitants in the Hinova village. Demographic growth between 1912 and 2017 was recorded in the administrative units: Breznita-Ocol with an additional 300 people, Şimian with 7,000 inhabitants and Drobeta Turnu Severin with 83,000 more inhabitants.

Evolution of the settlements population

To highlight how the population of human settlements evolved, we took the difference between the years from 1912 to 2011.

Very different values were found, ranging from + 624.29% to -86.70%. There are two categories of demographic evolution, growth and the decreasing number of the population.

Growth intervals:

- between 0 and +10%: Câmpu Mare (1,98%); Schinteiești (6,06%); Halânga (7,41%).
- +10% and +50%: Poroina (27,86%); Noapteșa (29,47%); Cârșu (29,56%).
- +50% and +100%: Brezniţa-Ocol (50,13%); Dudașu Schelei (62,10%); Magheru (98,68%).
- +100% and +200%: Dedovița Nouă (1948) (166,66%); Gura Văii (170,97%); Șimian (179,36%).
- over 200%: Drobeta Turnu Severin (285,75%); Dudașu (328,33%); Schela Cladovei (564,48%); Cerneți (624,29%).

Decrease ranges:

- between 0 and -10%: Bala de Sus (-1,95%); Bistrița (-2,42%); Balotești (-4,13%); Hinova (-9,62%).

- -10% and -30%: Izvoru Bârzii (-10,49%); Malovăț (-13,13%); Sărdănești (-18,04%); Jidoștița (-20,07%); Ostrovu Corbului (-21,65%); Crainici (-22,56%); Cocorova (-22,68%); Bala (-25,33%); Molani (-27,11).

- -30% and -50%: Rudina (-30,42); 23 August (-35,64%); Vidimirești (-36,82); Colibași (-37,19%); Șișești (-43,02%); Valea Copcii (-43,29%); Brativoiești (-45,42%); Dâlma (-45,96%); Puținei (-46,45%); Erghevița (-46,65%); Ohaba (-47,69%); Șovarna (-47,84%); Bratești (-48,55); Ciovârnășani (-48,97%).

- -50% and -70%: Iupca (-51,66%); Runcușoru (-52,89%); Cărămidaru (-53,14%); Schitul Topolniței (-53,54%); Dâlbocița (-54,96%); Crăguiești (-55,43%); Comănești (-57,62%); Cracu Lung (-57,96%); Răscolești (-58,72%); Ilovăț (-60%); Bârda (-60,45%); Studina (-60,59%); Bobaița (-65,15%); Negrești (-67,07%).

- over – 70%: Racova (-75%); Budinești (-76,41%); Șușița (-77,34%); Lazu (-79,53%); Firizu (-84,18%); Dedovița Veche (-85,86%); Cârjei (-86,70%).

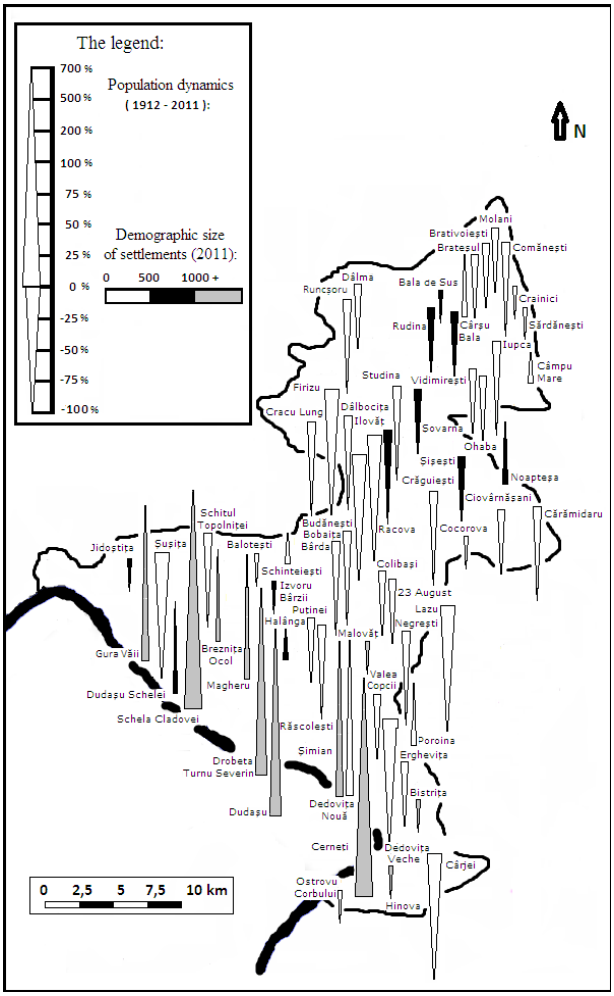

Figure 3. Demographic dynamics of settlements between 1912 and 2011
(Source: processed after: Proiectul Universității București- 1365, 2011; I.N.S. Mehedinți; Stroe and Peptenatu, 2011)

Between 1912 and 2011, the population of the two depressions increased by 100.0%, the evolution mainly due to Drobeta Turnu Severin with 285%, as well as of neighboring localities: Dudașu (328%); Schela Cladovei (564%); Cerneți (624%); Dedovița Nouă (1948) (166%); Gura Văii (170%); Șimian (179%); Breznița-Ocol (50%); Dudașu Schelei (62%); Magheru (98%); Schinteiești (6%); Halânga (7%). In addition to these human settlements, four other localities experienced population growth in the given interval, influenced by access to infrastructure (Câmpu Mare - 2%, Poroina - 27%), mining (Noapteșa - 29%) or near the spa resorts 29% (Cârșu, located near the balneoclimatic resort of Bala local interest) (Ianoș and Iacob, 1979). Of a total of 64 settlements located in the Mehedinti depressions, only 16 have registered population growth and managed to double the population of the two depressions.

The other 48 settlements, generally located at distant distances from the urban area and with poor infrastructure, have experienced population decreases, which lead to its half-life or exceed 70% of the local population 99 years ago, with the issue of dismantling or merging them. It highlights a positive demographic area that is limited to the urban environment and the surroundings of Drobeta Turnu Severin, an area with a low demographic decline the Danube meadow and in the low a Severin Depression and the Mehedintian Depression Corridor and a critical area of a shrinking demographic decline that includes in particular the deeply rural periphery dominated by the hilly villages (Olaru and Iordache, 2000; Lung and Diaconescu, 2019; Mazilu and Severineanu, 2007).

CONCLUSIONS

Between 1912 and 2011, the population of the two Mehedinti depressions doubled, being a sub-period of growth between 1912 and 1992 and a period of demographic decline between 1992 and 2011, except for the settlements near Drobeta Turnu Severin. Also, there is a clear differentiation between the two depressions and the entire Mehedinti County in favor of the first one due mainly to the demographic evolution of the city, but also a great difference between the two depressions, thus the Mehedintian Depressionary Corridor is in a continuous demographic decline on the whole period studied, during which the population of the Severin Depression experienced a real demographic explosion until 1992, following a decrease easier. Another major differentiation is given by the urban environment and the rural environment, so in the town of Drobeta Turnu Severin and the adjacent localities that can be considered as part of its urban agglomeration, the population experienced the highest population growths on the entire area of Mehedinți County, time where the rural population is experiencing population aging, strong emigration and low fertility, being in a severe decline.

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AGRICULTURAL LAND AND ACTIVITIES IN MUREŞ COUNTY

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Abstract: This study aims to analyse one of the most important land usages, that of agricultural land, which, in 2016, held 61.2% of the entire territory of Mureş County. Of all the land uses, the most extensive are arable lands (220,797 hectares), followed by pastures and hayfields (183,519 hectares), while orchards and vineyards occupied only 6,815 hectares. In terms of crops, grain is the most widespread (corn, wheat and rye, barley, oats), followed by fodder plants (alfa alfa, clover and corn), industrial plants (sunflower, canola, soybean, sugar beet), vegetables (tomato, cabbage, onion, edible root vegetables, pepper, cucumber), as well as potatoes and melons.

Key words: arable land, grain, horticulture, orchards and vineyards

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INTRODUCTION

This paper aims to tackle one of the main economic sectors of Mureş county, *agriculture*, the primary provider of produce for the population and raw materials for the food and light industry. The above mentioned objective was preceded by an extensive analysis of a set of secondary sector components, published in 2018 and 2019 (see references). We also want emphasize that the paper was presented in front of the specialists attending the scientific conference dedicated to 100 years since the founding of the Geographic School of Cluj (*Geographia Napocensis 100*), section Social-economic Resources and Sustainable development.

METHODOLOGICAL ASPECTS

Based on the official statistical data provided by Mureş Department of Statistics and Mureş County Agricultural Office, I created spatial systematizations and interpretations, which were later converted into graphical and cartographical media, thus facilitating the understanding process of the territorial reality. Mureş County Statistics Book for 2016 also points out that the data series

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regarding the agricultural surfaces based on usage remain „stuck" in 2014, until the cadaster of Romania is completed. Moreover, we consulted several studies which dealt with similar topics as our own (Cetină, 1981; Cocean et al., 2011; Cocean et al., 2013; Herman 2009a, b, 2010; Nimigeanu, 1996; Raboca et al., 2001; Păcurar, 2006; Pop, 1974; Șandru, 1978; Popovici & Mihail, 1980; Șoneriu & Mac, 1973; Tofan, 2013, 2018, 2019; etc.).

GENERAL STRUCTURE OF FIELDS

In 2016, the total surface area of Mureș County was 671,388 hectares, out of which 411,131 hectares (61.2%) are agricultural land, while 31.2% (209,451 hectares) are forests, and water 1% (6,388 hectares). The *"other surface"* category 6.6% (44,418 hectares) includes land occupied by buildings (3%, 19,921 hectares), communications routes (1.6%, 10,806 hectares) and degraded and nonproductive land (2%, 13,691 hectares). Agricultural land and activities are influenced by terrain, climate and soil, with *arable land* extending for more that a quarter of the entire county's surface area 32.8% (220,797 hectares). *Pastures* reach 16.3% (109,257 hectares), *hayfields* 11% (74,262 hectares), *orchards and nurseries* (0.8%, 5,151 hectares. *Vineyards and vine nurseries* (0.3%, 1,664 hectares) are modestly represented, being concentrated mostly in the hinterland of Reghin and the Târnave Corridor.

One may conclude that arable land holds more that half (53.7%) of the entire agricultural land in the county. Thusly, agricultural activities focus mostly on growing grain and fodder, which in turn stimulates the animal husbandry sector, mostly birds and swine.

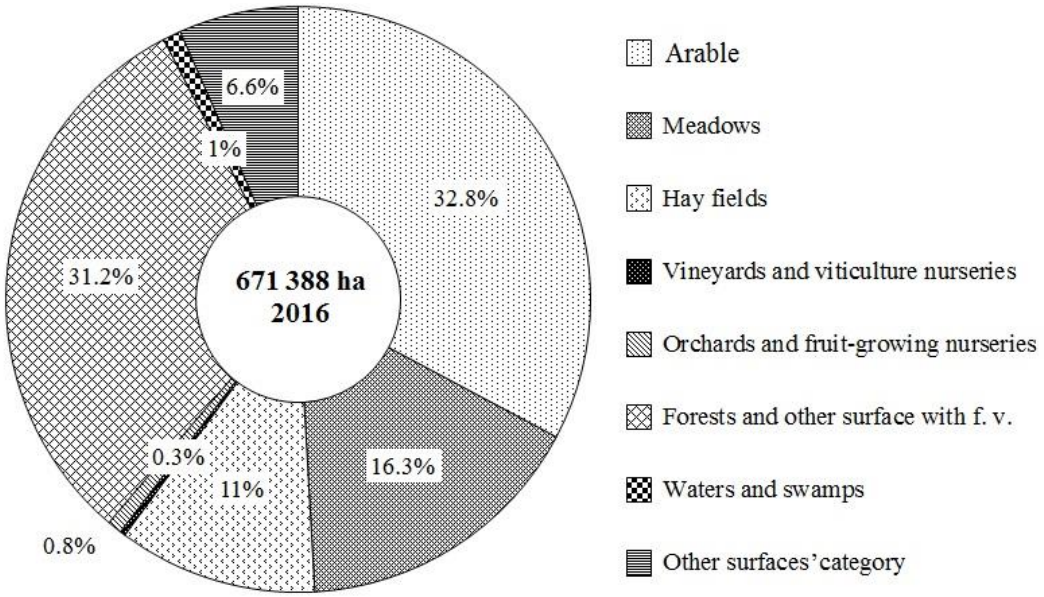

Figure 1. Mureș County. General land structure (agricultural, forests and other surfaces with forestry vegetation, waters and swamps and "other surfaces" category) and structure of agricultural fields (arable, pastures and hayfields, vineyards and viticulture nurseries, orchards and fruit-growing nurseries) in 2016 (f. v. = forestry vegetation)

ARABLE LAND AND PLANTS CULTURE

Compared to the average percentage registered at county level (32.8%, in 2016), and under the direct orographic influence, most arable lands are located in the western part of the county, in

the rural areas of Mureș Plain (Sărmaș Plain): Valea Largă (75.7%), Mădăraș (70.2%), Band (69.5%), Miheșu de Câmpie (67.2%), Grebenișu de Câmpie (65.5%), Pogăceaua (64.3%), Șincai and Șăulia (64.2%), Râciu și Sânger (63.3%), Zau de Câmpie (63%) and Pănet (60.5%), and the sole agricultural town of the Transylvanian Plain, Sărmașu, where arable land recorded values of 61%. Percentages above 60% were also found in two other communes (Sântana de Mureș, 71% and Cucerdea, 60.6%), in an urban area located in Mureș Valley (Iernut, 65%), as well as in Gănești Commune (60.6%) - Târnava Mică Valley. Fewer arable lands (percentages below 10%) are a characteristic of settlements located near or in Căliman and Gurghiu Mountains, for instance in Mureș Defile (Răstolița, 0.2%; Lunca Bradului, 0.3%; Stânceni, 1.1% and Deda, 9.5%); as well as Reghin Hills (Vătava, 4.1%); Valea Gurghiului (Ibănești, 2.1%) and the marginal areas of Sângeorgiu de Pădure-Sovata Hills (Sovata, 6.6% and Chibed, 9.8%).

In 2016, over half of the 220,797 hectares of arable land in the county were cultivated with *grain* (119,701 hectares), followed by *fodder plants* (48,412 hectares), *technical plants* (17,447 hectares) and *vegetables, potatoes and melons* (12,821 hectares). The remaining 22,416 hectares were used for cultivating *strawberries* (34 hectares), *flowers and ornamental plants* (52 hectares), while 22,330 hectares are categorised as unused farmland.

a) Grain growing extends on 54.2% of the county's arable land, mostly in lower areas, known as one of the bread baskets of the Transylvanian Depression (Pop, 2012, p. 185). Gentle hills are highly suitable for said crop, especially corn, 32.7%, followed by wheat and rye, 14%, barley, 3.7%, oats, 2.6% and other cereals (triticale, millet, sorghum), with 1.2%.

Corn is the apex crop (32.7% of arable farmland), covering 72,231 hectares (2016). The average yield in Mureș County is roughly 4,500 kg/hectare. The largest surface areas cultivated with corn are in Mureș Plain (Band, 3,447 hectares; Pănet, 2,184 hectares; Zau de Câmpie, 2,039 hectares; Sânger, 2,040 hectares; Sărmașu, 1,987 hectares; Valea Largă, 1,458 hectares and Miheșu de Câmpie, 1,056 hectares), in Mureș Valley (Iernut, 3,111 hectares; Cheţani, 1,633 hectares; Luduș, 1,560 hectares; Sânpaul, 1,132 hectares; Ogra, 1,090 hectares and Ernei, 1,051 hectares), as well as in lower basins of Niraj and Târnava Mică valleys (Bălăușeri, 1,380 hectares; Adămuș, 1,373 hectares; Aţintiș, 1,253 hectares; Acăţari, 1,224 hectares; Bahnea, 1,033 hectares and Bichiș, 1,007 hectares). This is due to the presence of mollisols and clay soils, chemically and biologically suitable for such a plant, but only when agro-technical improvements are introduced (Pop, 2007, p. 180). At higher altitudes, due to the high extent of technical plants and improper weather conditions, corn cultivated farmland decreases considerably (below 50 hectares), in communes such as Chibed, Corunca, Eremitu, Stânceni and Lunca Bradului.

To increase the average production per hectare (Cetină, 1981, p.159), the authorities and private entrepreneurs introduced several hybrids, such as the ones developed by *Pioneer Optimum AQUAmax* (P9241, P9415, P9757, P9486, P9903), with a 114-124 day vegetation period, leading to more than 10,000 kg/hectare in Gănești, Glodeni, Acăţari, etc.

Grain (30,463 hectares in 2016) has favourable development conditions especially in the lower areas of the county, where arable farmland exceeds 50% (Band, Sărmașu, Râciu, Sânpetru de Câmpie, Pogăceaua, Pănet, Miheșu de Câmpie, Iclănzel, Iernut, Luduș, Ungheni, Ernei etc), with average yields of roughly 4,000 kg/hectare. According to Mureș Agricultural and Rural Development Office, 2017 saw the highest production in the entire history of the county, 5,810 kg/hectare. In the mountainous area surrounding Mureș Defile, such crop is missing. However, low rentability caused by poor mechanization, lack of workforce and the agricultural market instability provoked a decrease by more than half in the cultivated farmland between 1990 and 2016. The main types of wheat found in Mureș are: *Andrada, Apache, Apullum, Ardeal 1, Arieşan, Boema 1, Glosa KG Kungloria, Renan, Acteur, Bitop, Exotic, Midas, Othectareslom, Kristina*, etc.

Almost the entire surface area cultivated with autumn type wheat, while hard wheat (*Trtiticum durum*) is cultivated in experimental patches (57 hectares). In higher areas, with poorer pedoclimatic conditions, people grow rye (Raboca et al., 2001, p. 41). However, said crop has

considerably lost surface area (Popovici & Mihectaresil, 1980, p. 176), reaching 193 hectares (2016), while the average yield being 2400 kg/hectare, mostly on private farmland.

Furthermore, many cultivate a hybrid between wheat and rye (*triticale*), used as animal fodder, beer malt and in alcohol production. A major advantage is its resistance to diseases and harsher climatic conditions (its does not require herbicides), while seeds open much sooner than other plants (Cocean et al., 2013, p. 206). Therefore, in 2016, there were 2,446 hectares of autumn triticale and 268 hectares of spring triticale, with an average county yield of roughly 2,500 kg/hectare. The largest farmland cultivated with triticale were recorded in Sângeorgiu de Pădure Hills (Miercurea Nirajului, 200 hectares, Bereni, 160 hectares and Sângeorgiu de Pădure, 104 hectares).

Barley was modestly represented in 2016, extending on 8,204 hectares (3.7%) of the total arable land of the county (220,797 hectares). It is primarily used as animal fodder and in beer making. It is mostly cultivated in Sărmașului Plain (Band, Iclănzel, Miheșu de Câmpie, Grebenișu de Câmpie), Mureș Valley (Gornești, Ogra, Luduș) as well as in the hills and valleys of Târnave (Băgaciu, Aţintiș), From 2006 to 2016, average county production increased from 2,236 kg/hectare to 3,387 kg/hectare.

Oats is mostly found in the cooler and wet areas of the eastern part of the county (Miercurea Nirajului, 395 hectares; Măgherani, 200 hectares; Hodac, 170 hectares; Suseni, 166 hectares; Breaza, 150 hectares; Aţinţiș, 118 hectares, etc), where soil fertility is lower. In 2016 it occupied 2.6% (5,782 hectares) of the total arable farmland and yielded 2,437 kg/hectare. Large surfaces cultivated with oats can be found in lower areas, as said lands may find a superior usage as bearers of other plants (Lunca, 541 hectares; Tăureni, 176 hectares; Râciu, 150 hectares; Cozma and Iclănzel, 120 hectares). Production was around 2,000 kg/hectares and was used as horse fodder, but also as food for younglings and diabetics - flower, cereal and semolina.

Besides said („main") grain, other, secondary, grain crops are cultivated (Păcurar, 2006, p. 58), such as *sorghum* (82 hectares, out of which 60 hectares in Sântana de Mureș) and millet (32 hectares out of which 25 hectares in Reghin).

b) Fodder found optimal growth conditions in lower areas, but also at higher altitudes, and play a crucial role in the animal husbandry sector. In 2016, fodder plants claimed 22% (48,412 hectares) of the county's arable land, mostly *old and new perennial plants* (16.8%), followed by *hay and green mass plants*, and *silo plants*, both with 2.5%. The most widespread perennial plants in the county are *alfa-alfa and clover*. The former increased in surface area in the last two decades due to the ever increasing need for fodder, but also due to its nutritional value, from 9,231 hectares (1990) to 18,890 hectares (2016). According to statistical data, the most extended areas were recorded in Ceuașu de Câmpie (951 hectares, 24.8% of the commune's arable land), Râciu (946 hectares, 20.3%), Sărmașu (715 hectares, 15.4%) and Band (695 hectares, 11.1%).

Clover, more resilient to lower temperatures, but requiring a substantial amount of rainfall, lost almost half of its surface area (only 3,559 hectares in 2016), with cloverfields around Band, 420 hectares (largest surface in the county), as well as Ernei, Glodeni, Miercurea Nirajului, Găleşti, Batoș, Acăţari, etc., with areas measuring approximately 100-200 hectares. Other perennial plants cover 14668 hectares, and are present in 83 administrative-territorial units, mostly in the communes of Hodoșa (830 hectares), Șincai (800 hectares) and Sovata (675 hectares).

Yearly hay and green mass plants cover 5,710 hectares, with oat, rye, meslin, fodder peas, etc., found predominantly in the Transylvanian Plain (Glodeni, Fărăgău, Șincai, Sărmașu, Sânpetru de Câmpie, etc) and the submountain depressions (Miercurea Nirajului, Eremitu, Bereni, etc).

Silo plants (5,585 hectares) are dominated (98%) by silo corn (5,461 hectares), while *root fodder plants* (fodder beet and courgette) occupy 124 hectares.

c) Technical plants occupy the third largest agricultural area (17,447 hectares, 8% of the cultivated arable land, in 2016), with three groups: *oil plants* (sunflower, 5,244 hectares; rapeseed, 4,974 hectares, and soybean, 4,368 hectares), *other industrial plants* (sugar beet, 2,299 hectares, millet, 204 hectares, tobacco, 98 hectares, sorghum, 88 hectares, and energy willow, 36 hectares) and

medicinal and aromatic plants, with 136 hectares. In the 1990s, large areas (3,494 hectares) were covered with textile plants. However, hemp and flaxseed are no longer cultivated.

Sunflower, with an average temperature of 8^0C as its fruiting limit (Nimigeanu 1996, p. 198), covers large areas (100-300 hectares) in the western, warmer extremity of the county (Sărmaşu, Band, Grebenişu de Câmpie, Miheşu de Câmpie, Ogra, Pogăceaua, Râciu, Sânpetru de Câmpie), as well as areas around: Târnăveni, Iernut, Luduş, Ungheni, Adămuş, Ibăneşti, Suplac, Viişoara, etc, with a total of 5,244 hectares (2.4% of the arable land, in 2016). Taking into account the ever increasing cooking oil of the population, Mureş County experienced an increase in sunflower yield from 556 kg/hectare in 1990 to 2,189 kg/hectare in 2016, mostly on privately owned land.

Rapeseed is increasingly used in the production of industrial products (mechanical lubricant, biofuel, cosmetics and pharmaceutics), as well as in the food industry (extravirgin oil and margarine), and animal fodder (Geografia României, II, 1984, p. 343). Land covered by rapeseed crops increased from 303 hectares in 2007 to 4,974 hectares in 2016 (2.2% of the county's arable land). The largest extent – Mureş Valley (Iernut, 654 hectares; Sânpaul, 382 hectares; Ungheni, 371 hectares and Ogra, 315 hectares). Another extensively used oil plant is the *soybean*. In 2016, soybean registered a percentage of 2% in Mureş (4,368 hectares), with an average growth per hectare of over three times from 1990 to 2016 (2,010 kg/hectares in 2016). Important soybean production centres - Iernut, Bahnea, Râciu, Pogăceaua, Băgaciu and Târnăveni.

Sugar beet, with 1% of the county arable land, is cultivated on large plots of land in the Transylvanian Plain (Band, Pogăceaua), Mureş Valley (Luduş area) and Târnave Plateau (Târnăveni, Daneş, Găneşti), where pedoclimatic conditions are perfect for said crop. In order to reduce production costs (Şandru, 1978, p. 227), there were several large sugar processing units in Târgu-Mureş (*Sugar Beet Processing Enterprise*, rebranded *Zamur* after 1990) and Luduş (the former *"Zahărul" Luduş plant,* privatized in 2013 and sold to the French *Tereos Consortium*), with a processing capacity of 4,000 tonnes/day (Tofan & Niţă, 2018, p. 50). In the last two decades, sugar beet production declined considerably (from 10,504 hectares in 1996 to 2,299 hectares in 2016), due to the introduction of the sugar quota, price liberalizations, and high fertilization costs. This contributed to the closure of many plants, among them the one located in Târgu-Mureş.

Hops fields are found solely on the southern exposure slopes of Târnava Mare Valley (area around Sighişoara), occupying 204 ha (Sighişoara 95 ha; Saschiz 60 ha and Daneş 49 ha). It is mostly used in beer making, and a small part in pharmaceutics.

Figure 2. Millet growing in Târnava Mare Corridor, Daneş

Tobacco has experienced a steady decline over the years, caused by the shutdown of processing plants. This led to a reduction of acreage, from 1,159 ha in 1990, to 98 ha in 2016, the entire production being exported abroad. Two types are cultivated in the eastern part of the Transylvanian Plain (*Virginia*, with a medium concentration of nicotine, and *Havana*, for cigars and cigarillos) (Pop, 1974, p. 240).

Figure 3. Tobacco growing in Transylvanian plain, Sărmăşel Gară

Last but not least, there are plots of land cultivated with *sorghum*, used for manufacturing brooms (88 ha), and *energy willow* (36 ha), used for making pellets.

The last group of technical plants is represented by medicinal and aromatic plants, grown on a surface area of 136 ha. However, the vast majority of plants are harvested from spontaneous flora, with some processing units functioning in Ibăneşti, Reghin and Sovata, which produce a multitude of tea products.

d) Vegetables and potatoes are crucial for man's nutritions needs, as well as for the entire food industry (Nimigeanu, 1996, p. 207). In 2016, the surface area cultivated with vegetables and potata reached 12,821 hectares (5.8% of the county's arable land), with emphasis on *vegetables* (3.2%), while potatoes 2.5%.

Vegetable crops enjoy the very best natural conditions, especially along the valleys and terraces of Mureş, Niraj and Târnave rivers, with wet alluvial soils, which can be effortlessly cultivated. The surface area covered with vegetables was 7,134 hectares in 2016, with just 10 hectares integrated in the intensive agricultural system (greenhouse). Most of the fresh produce are grown outside, in family farms, with a wide array of species, especially tomatoes, 1,246 ha; but also pepper, 560 ha and eggplant, 250 ha), *onion*, 1,032 ha and garlic, 313 ha), *white and red cabbage*, 1,209 ha, cauliflower, 115 ha), *root vegetables* with 1,016 ha (largest extent - carrot, 660 ha; followed by parsley, radish, parsnip, celery and red beet), pulse (seed beans, 112 ha; seed peas, 355 ha; pod beans, 317 ha and pod peas, 176 ha), *gourd* (cucumber, 465 ha, green melon, 92 ha, yellow melon 64 ha) and *leaf vegetables* (salad, spinach, 435 ha).

Mureş County contains three large vegetable growing regions, the first located in the Transylvanian Plain (Mureş Plain), and the second along the valleys of Târnava Mică and Niraj.

Two additional regions were identified – the submountain hills and depressions (Reghin Hills and Sângeorgiu de Pădure Hills) and Mureş Corridor.

The Transylvanian Plain, and especially its sourthern part (Mureş Plain), is highly diversified in terms of vegetable crops, mostly around Band, Grebenişu de Câmpie, Ceuaşu de Câmpie and Râciu, where almost all previously mentioned vegetables are grown (carrot, parsley, celery, beet, onion, garlic, peas, cabbage, cauliflower, cucumber, tomato, pepper, eggplant).

The Târnava Mică and Niraj Corridors comprise of large plots of land cultivated with vegetables – around the town of Târnăveni (tomatoes, 50 hectares, 1.8% of the total arable land; cabbage, 27 hectares, 1.0%; root vegetables , 23 hectares, 0.8%; onion, 21 hectares, 0.8%; pepper, 15 hectares, 0.5 %; cauliflower, 8 hectares, 0.2% and eggplant 5 hectares, 0.2%), as well as some rural areas (Adămuş, Mica, Bahnea, Suplac, Crăciuneşti, Gheorghe Doja, Acăţari, Găleşti, Vărgata), with roughly the same range of crops.

The last two smaller areas include parts of *Reghin Hills* and *Sângeorgiu de Pădure Hills*, best known for the cultivation of the red onion of Buzău (also known as "water onion"), garlic, cabbage, tomatoes, cucumbers and peppers (around Reghin), in centres such as: Reghin, Ideciu de Jos, Suseni, Brâncoveneşti, Hodac şi Ibăneşti, Chibed, and Bălăuşeri.

Mureş Valley is highly favourable for the cultivation of cabbage, beans, bulb vegetables and as well as tomatoes, eggplants and peppers, in areas such as Iernut, Luduş, Gorneşti, Cuci, Cheţani and Bogata.

Potato cultivation (5,531 hectares, 2.5% of the arable land in 2016) finds proper conditions in hill areas, on gentle slopes, prefering a cool and damp climate. Potato fields can be found across the entirety of the county. It is represented almost exclusively by autumn potatoes (91.3%), while early and summer potatoes are mostly grown in lower areas and in the vicinity of urban areas, alongside vegetables (Şoneriu, Mac, 1973, p. 137). The largest autmn potato fields are found in the towns of Band (280 hectares), Bălăuşeri (216 hectares), Ernei (185 hectares), Acăţari (152 hectares), Luduş (140 hectares) and Ibăneşti (130 hectares). In terms of average potato yield per county, between 2006-2016, the largest quantity was recorded in 2016 (19,386 kg/hectare) and the lowest in 2012, only 9,724 kg/hectare.

Pastures and hayfields

This land category forms the fodder basis for animal husbandry. Compared to the county surface area, it holds the second place after arable land, with 27.3% (183,519 hectares). Pastures have a relative value of 16.3% (109,257 hectares), while hayfields 11% (74,262 hectares).

a) Pastures register different values both in terms of nutritional content as well as in their territorial distribution across the county. Most territorial units record values between 10-20% (57), the lowest percentages being found in the City of Târgu-Mureş (2.2%, 110 hectares), Crăciuneşti (3%, 148 hectares), Reghin (5.7%, 321 hectares) and Cristeşti (5.7%, 76 hectares), and the highest in Chibed (43.2%, 1,580 hectares), Veţca (33.3%, 1,249 hectares) and Brâncoveneşti (31.5%, 2,756 hectares). Areas with 20-30% can be found solely in two communes located in the Toplița-Deda Corridor (Răstolița, 5,032 hectares and Lunca Bradului, 4,759 hectares) (G. B. Tofan, 2014, p. 96), as well as in the marginal submountain depressions of Reghin Hills (Gurghiu, 2,696 hectares, Hodac, 2,121 hectares and Vătava 2,084), Northern Hârtibaciu Plateau (Apold, 2,595 hectares) and Târnava Mare Valley (Daneş, 2,102 hectares).

b) Unlike natural fields, ***hayfields*** have an sizeable plant richness and a higher nutritional value for animals, but their surface area remains low (74,262 hectares). Most are found in Reghin Hills (Deda, 33%, 2,524 hectares, the highest percentage in the county), Aluniş (32%), Ideciu de Jos (29%), Solovăstru (28%), Ruşii-Munţi (27%), Vătava (26%), Brâncoveneşti (24%) and Beica de Jos (22%), as well as in the Târnava Mica Valley, at Sărăţeni (29%) and Adămuş (23%). The lowest percentages were recorded in the Mureş Plain and the valleys of Mureş and Niraj, meaning that 61 of the total 102 administrative-territorial units in the county have relative values of below 10% (Târgu-Mureş, 2.2%, 108 hectares, the lowest in the county). This is partly due to a larger

extension of arable lands (such as the case of Sântana de Mureş, where there were no records of hayfields), as well as to the presence of forested and pasture areas in the mountains.

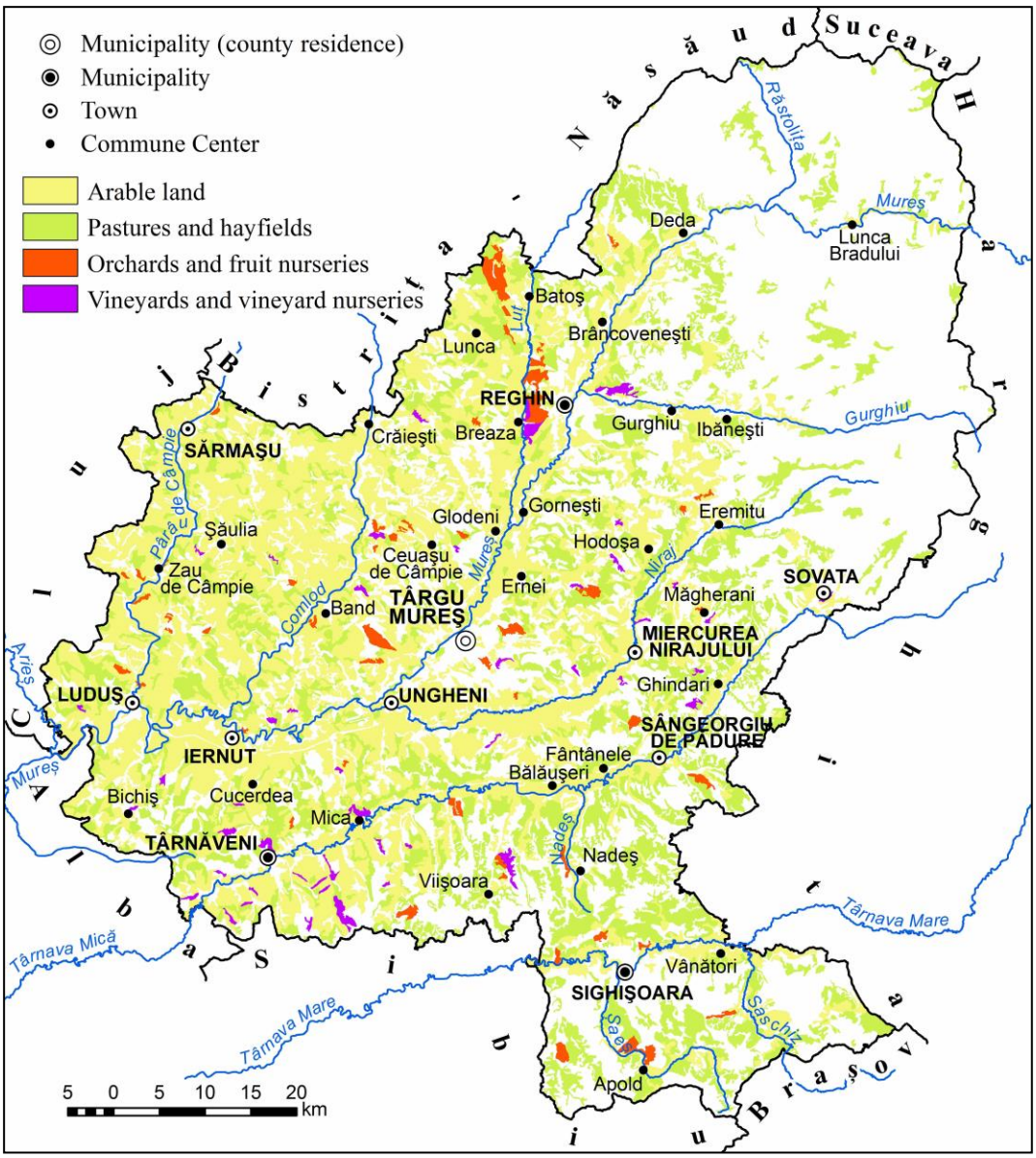

Figure 4. Mureş County. Agricultural land usage map
Source: after Corine Land Cover 2016

Orchards and nurseries

In some parts of Mureş County, pomiculture has been blessed with favourable oropedoclimatic conditions, as well as a certain tradition. In 2016, compared to the entire surface area of the county, orchards covered 0.8% (5,151 hectares), half being active (2,694 hectares), the remaining hectares being young orchards, nurseries, and decrepit orchards. Thusly, the higher area covering the eastern part of the county hosts the fruit growing region *of Reghin*, with a surface of

1,473 hectares (Batoş, 765 hectares; Reghin, 511 hectares and Breaza, 197 hectares). The area is dominated by apple cultivars, such as *Golden Delicious, Jonagold, Pinova, Jonathan, Idared, Red Delicious, Florina* and *Generos*. Some areas are covered by plum, cherry and pear trees. Moreover, there are other, smaller, fruit growing areas in the Transylvanian Plain (Pănet, 444 hectares and Ceuaşu de Câmpie, 145 hectares) and Târnave Plateau (Apold, 436 hectares; Suplac, 215 hectares; Livezeni, 203 hectares; Bahnea, 140 hectares; Daneş, 120 hectares, etc.). These are dominated by plum trees, followed by apple, pear and walnut, and, in some areas, even peach and apricot trees.

Vineyards and nurseries

In 1990, the surface area covered with vineyards was 4,916 hectares. However, following the retrocession process, the vineyards dropped to 1,664 hectares (0.3% of the county territory) in 2016, with 964 hectares of active vineyards (690 hectares graft and 274 hybrid) and 4 hectares of vineyard nurseries. Taking into account the exposure, orography, climate, soil cover and structure, the vineyards compose a relatively large wine region, *Târnave Wine Country*. It is one of the oldest and most well-known wine areas in the country, covering the sunlit slopes of Mureş Corridor and parts of the Târnave valleys (Geografia României, II, 1984, p. 359). Mureş County has has three wine producing centres: *Târnăveni* (encompassing the communes of Adămuş, Băgaciu, Găneşti, Mica, Suplac, and Bahnea), *Zagăr* and *Nirajului Valley* (Zagăr, Viişoara, Coroisânmartin, Bălăuşeri, Fântânele, Nadeş, Acăţari, and Crăciuneşti). Grapes are mostly used to produce wine, with sparkling wines, both white (*Gewurztraminer, Chardonnay, Pinot Gris, Muscat Ottonel, Sauvignon, Neuburger, Riesling Italian, Riesling de Rhin, Fetească Regală, Fetească Albă, Furmint*), and red (*Cabernet Sauvignon, Pinot Noir, Fetească Neagră, Syrah, Merlot*) (Şoneriu, Mac, 1973, p. 138). Other wine making centres can be found in Batoş, Ceuaşu de Câmpie (village of Culpiu), Band and Mădăraş, part of *Lechinţa*, which, alongside Târnave Area, produces excellent wines.

CONCLUSIONS

In 2016, out of the entire surface area of Mureş County (671,388 hectares), 61.2% or 411,131 hectares or the vast majority was agricultural land. Out of this, more than half was arable (220,797 hectares), followed by pastures and hayfields (183,519 hectares). The remaining land was occupied by orchards and vineyards (6,815 hectares). Arable land was most extended in the western part of the county, in the Mureş Plain and Corridor, where grain plant growing is the most mature (119,701 hectares), thus making the region one of the *„bread baskets of Transylvania"*. There are also considerable areas cultivated with fodder plants (48,412 hectares), which supports a strong animal husbandry sector.

I identified a decline in hemp, sugar beet, millet and tobacco plantations, while the high demand for cooking oil led to an extension of sunflower, rapeseed and soy plantations. Vegetable and potato fields are found across the entire county, with four large cultivation areas: Mureş Plain and Târnava Mică-Nirajului (more extended), as well as Mureş Corridor and Reghin - Sângeorgiu de Pădure Hills (less extended), where production are traded as well as used in house.

Pastures and hayfields are mostly on the eastern hills and depressions (Reghin Hills), as well as in the mountains (Topliţa-Deda Defile), (Tofan & Păcurar, 2013, p. 335), less so in lower areas. Orchards and vineyards declined extensively in the past three decades due to the retrocession process, as the new owners failed to maintain and reinvigorate said plantations, which in turn led to low yields.

Geographically speaking, pomiculture is more extended in the *Reghin Basin*, while viticulture in the *Târnave Area*, with centers in Târnăveni, Zagăr and Valea Nirajului, as well as *Lechinţa Areas*, mostly in Batoş, Ceuaşu de Câmpie, Band and Mădăraş.

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TOURISM AND LOCAL DEVELOPMENT IN THE CRIŞUL REPEDE VALLEY, BIHOR COUNTY, ROMANIA

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Abstract: The present study aims to analyze the influence of tourism activity on the environment in the protected area Defileul Crişului Repede, Bihor County, Romania. In this sense, using a series of specific methods, methods and analysis techniques (field observation, analysis and synthesis), the role of tourism in the local economy, its impact on the environment and the socio-economic component were analyzed. The conclusions of this scientific endeavor highlighted some positive aspects regarding the development of tourism in this protected area. As a result of this, after consulting the population and the local authorities, there was an attempt at identifying some recommendations and measures to implement a sustainable tourism, in accordance with the needs of the local population, which will contribute to the diversification and development of the local economy.

Key words: Crişul Repede Nature Reserve, Sustainable Development, Sustainable Tourism

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INTRODUCTION

The Defileul Crisului Repede reservation with an area of 219.70 ha is located in the central part of Bihor county, in the Pădurea Craiului Mountains, between the towns of Suncuiuș and Vadu Crișului, on both sides of the Criș Repede, along the county road. DJ108I and the Cluj-Oradea railway bus (Herman et al., 2019b; Olău, 2019). Considering the floristic, faunistic and geological importance of this area, through Law no. 5 of March 6, 2000 regarding the approval of the Plan for the development of the national territory - Section III - protected areas an area of 219.40 hectares was declared a protected area, it overlapping over the area of Natura 2000 Site Defileul Crișului Repede - Pădurea Craiului. Natura 2000 site The Crișului Repede - Pădurea Craiului defile, ROSCI 0062, is part of the Natura 2000 Ecological Network, having functions in the conservation, protection and capitalization of the natural heritage in order to promote and impose a sustainable social-economic development of the territory (Tatar et al., 2018; Ianoș et al., 2009; Ilieș et al., 2018). The Natura 2000 Romania Ecological Network with an area of 5555854.13 ha, respectively 23% of the surface of Romania (Ilieș et al., 2017) consists of 383 Special Areas of Conservation (SAC) and 148 Special Protection Areas (SPA) with a major role in conservation the species and habitats provided in the annexes of the two directives: "Habitats" 92/43 / CEE and "Birds" 79/409 / CEE.

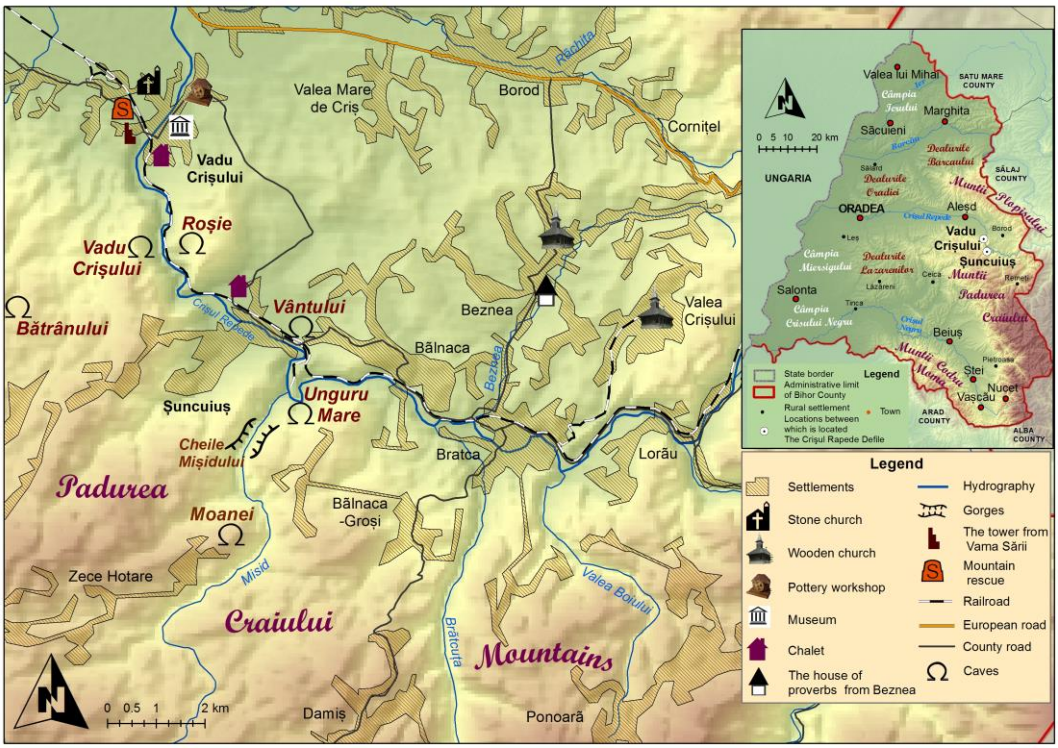

Figure 1. Physical geographical location

The physical-geographical characteristics and spatial location favored the existence of 16 types of habitats, as well as numerous species of community interest, provided in Annex II of Council Directive 92/43 / EEC (16 species of mammals, 3 species of amphibians and reptiles; 5 species of fish; 2 species of invertebrates; 3 species of plants. In addition, other important species of flora and fauna coexist. The natural habitats representative for the area of Natura 2000 site. deciduous, coniferous and mixed forests (Standard sheet Nature, 2000 - Defileul Crișului Repede - Pădurea Craiului, ROSCI0062).

In this context, it is necessary to analyze the way in which tourism could be a factor generating local development, by creating new jobs and sustainable exploitation of the existing tourism potential (Rojanschi et al, 2004; Herman et al., 2017; Ilie et al., 2017). The implementation and development of sustainable tourism can contribute to a better capitalization of the protected area analyzed, with direct social and environmental benefits (raising the awareness among the population regarding the ecological importance of the fauna and flora, as well as the need for their conservation, strengthening cohesion at community level), economic (new jobs, technical and urban infrastructure development, improving living conditions) and identity (increasing interest in one's own culture). Tourism has "a considerable impact on the economies, societies and cultures of the different countries of reference" (Pierre, 1986). It can help maintain local cultural identity (Caciora et al., 2019; Herman, 2012; Herman and Gherman, 2016; Herman and Benchiș, 2017; Herman et al., 2018b), which might otherwise be lost in the dominant trend of globalization (Clark, 1997; Held et al., 1999; Kacowicz, 1999; Herman et al., 2016; Herman and Grama, 2018). The involvement of local communities in the development and functioning of tourism is an important condition for the conservation and sustainable use of local heritage.

RESEARCH METHODOLOGY

In order to carry out the present study I have resorted to the study of the specialized literature and to the field research. The methods used were field observation, analysis and synthesis of the results thus obtained. During the field activity were held discussions with 25 people from the locality from various fields of activity, among which were the tour guide Ungur Carmen (from Bălnaca village, owner of the land around the Ungurul Mare cave, passionate about speleology and site history archaeological of the cave), a local shepherd, originating from the village of Șuncuiuș, owner of a sheep herd, a local from the area of Vadu Crișului who was in charge of gathering medicinal plants and berries, the owners of the Perla Albastra Hostel in Șuncuiuș, a family of local entrepreneurs who deal with raising cattle for milk and have opened milk distribution points throughout the commune Șuncuiuș, by placing milk dispensers.

CONSERVATION AND PROMOTION OF NATURAL AND CULTURAL-HISTORICAL HERITAGE

Although the area studied has many caves, enhanced by tourist arrangement are only Vadu Crișului Cave and Unguru Mare Cave. Vadu Crișului Cave is located in the center of the gorge sector between the towns of Șuncuiuș and Vadu Crișului, on the left bank of Crișul Repede, near the stop. The cave that serves it on the railway. Undergoing a rehabilitation project in 2004, the cave impresses with the richness of the speleothems, the cave fauna but also through the underground stream that is thrown into the waters of Criș through an impressive waterfall, itself a tourist objective. The Unguru Mare cave is located in the first sector of the gorge, developed between the localities of Bălnaca-Șuncuiuș, which impresses through the great meander created by the Crișul Repede river, in the form of a horseshoe at the base of Simion's Hill, thus completing the tourist offer of the area. It is worth noting the importance of tourism for the conservation of the archaeological site of the Unguru Mare Cave. The tourist visits and the creation of an interior museum led to the introduction of the cave in the tourist circuit.

Immediately downstream are located the Mișidului Gorges and two other cavities, the Cave of the Wind (Peștera Vântului) with a length of 47 km and the Cave of Moana (Peștera Moanei), known for its prehistoric remains. Both, along with eight other caves in the Pădurea Craiului Mountains, were included in the network of specialized speleological tourism (starting with 2016 the first network of species-based caves in Romania was made sustainable development of the karst heritage), through a European financing project regarding the arrangement of the main caves in the karst ensemble existing in the Pădurea Craiului Mountains, under the coordination of the CAPDD. The common element in the arrangement of the entire cave system is the preservation of the natural geological and biological elements as real as possible. By the impressive number, as

well as by the spectacular and monumental nature of the underground landscapes (palentological vestiges, erosion terraces, meanders, horns, waterfalls, large variety of speleotherms), the caves represent important tourist resources.

The richness and beauty of the natural heritage of the Defileul Crișului area is complemented by the diversity, beauty and uniqueness of the cultural-historical heritage elements represented by architectural monuments such as the Vadu Crișului Wall Church (BH-II-mB-01224) or the Tower of Salt Customs "Portus Criș" or Casa Zmăului (BH-II-mB-01023). [1] Built in the 13th century on a rock near a cave at the exit of the Defileul Crișului Repede on the right, it had the role of overseeing and clearing the floats carrying salt on Criș. The barren spine-type fortification on Simionului Hill - Șuncuiuș dating from the Iron Age is in the attention of the authorities for a future valorization, by revealing the traces of the fortification and its inclusion in the tourist circuit. The wooden churches that have been preserved in Beznea and Valea Crișului, the ethnographic and religious museum in Vadu Crișului, the House of Proverbs in Beznea, the potter's workshop Petru Hașas in Vadu Crișului are other examples of heritage identity with the possibility of valorisation through tourism (Herman and Wendt, 2011; Ilieș et al., 2016). The pottery workshop Petru Hasas can be constituted as a model of economic valorization of an ancient craft, the white ceramics decorated with dark brown specific to the town of Vadu Crișului is unique in the country. The originality, the extraordinary elegance characterized by simplicity creates a note of timelessness that allow it to be present in the contemporary as decorative pieces.

One of the most recent projects (September 2018) under the Interreg Va Romania - Hungary 2014 - 2020 Program, which has as an investment priority the conservation and protection of nature on both sides of the Romanian-Hungarian border (Pronature), aims at the rehabilitation and transformation of the Cabin Vad (Zichy) in a visiting center with thematic exhibition spaces but also the creation of a Center for the Promotion of the traditional culture - the Olar House in order to protect and conserve the community resources through events. [2]

Another positive effect on the preservation of the cultural heritage of the region is the inclusion of historic wooden churches in the tourist circuit. For this purpose, the wooden church of St. Archangel Michael and Gavriil-from Valea Crișului was included in the route organized on the occasion of the rediscover the Bihor Bicycle-Road of the Wood Churches. This type of tourist activity, has the role of promoting the wooden churches historical monuments from Bihor county and implicitly from the Crișul Repede Gorge, to be taken into account as cultural tourist objectives, with the purpose of preserving, monitoring and restoring them, for a sustainable tourism. in the region.

Thus the anthropic objectives, in addition to the natural ones, come to complete the tourist complexity of the parade and to contribute to attracting as many tourists as possible. When visiting these wooden churches historical monuments, activities of cyclotourism, tasting of traditional products and hiking are combined (Dincă et al., 2012; Ilieș et al., 2013).

The immaterial heritage that is also valuable is promoted and exploited by the folkloric ensembles in the area or in some festivals, the best known, with a long tradition being the Fair of the Salt Hall. It promotes traditional culture through the parade of folk ensembles in Bihor. Although it takes us more to a peasant celebration than to an ethno-folklore festival, it reminds us of the salt clearance on Crișul Repede at the entrance to the town and through longevity, this year the edition with number 51 took place, benefiting from a wide recognition.

Among the most representative forms of tourism are the tourism, in Vadu Crișului and Unguru Mare Cave arranged for mass tourism, specialized tourism in the Wind and Moana Cave, mountaineering / climbing and mountain hiking, with old tradition, or more recent forms very well received in tourists like rafting, via ferrata and cycling. Crișului Repede Gorge is a nationally known climbing area with 20 sectors, totaling 281 routes. Via ferrata is practiced on four routes,

[1] *www.cimec. ro*
[2] *https://oradeaindirect.ro/cabana-vadu-crisului-va-fi-transformata-intr-un-centru-multifunctional/*

the Fairy Wall and the Casa de la Zmeului, the route within the Montana Land adventure park and the Hodoaba Valley trail located on the wall of the Unguru Mare Cave next to the Tyrolean which leads to the transformation of the area.[3] Great Unguru Caves in a real adventure area. Rafting is practiced on a distance of about 3 km between Șuncuiuș, next to the Unguru Mare cave towards Vadu Crișului, the area with the most attraction which has three more difficult areas.

Starting with the year 2017, in Șuncuiuș, there is an important mountain running competition Primavera Trail Race which was the basis for the subsequent marking of the running routes. Most of the hiking trails in the Pădurea Craiului Mountains are marked in, or starting from, the Crișului Repede Gorge, 7 of 13, and in the gorge to the Vadu Crișului Cave, the thematic route "Without a trace!" Was created, an informal education tool. for the environment and for the appreciation of the values of the protected area. Since 2013, a mountain guard has been operating in Șuncuiuș, which, besides the protection and rescue services in the mountain area, promotes mountain tourism.

LOCAL ECONOMY

Tourism has proven to be one of the most dynamic economic sectors both globally and locally, with remarkable effects in terms of sustainable development of local economies (Bercu, 2015; Boccella et al., 2016; Drăghici et al., 2015; Dumitru, 2007; Herman et al., 2017; Herman et al., 2018a; Ilie et al., 2017; Rogerson, 2015; Rojanschi et al., 2004; Pires et al., 2015). The idea of adopting the concept of sustainable development in tourism emerged in the last period, thus creating sustainable tourism (Butler, 1999; Carlo, 2014; Xin et al., 2013). Thus, the sustainable development of tourism starts from the idea that the economy and the environment are two facets of the same currency, so, like them, they are inseparable (Sharpley et al., 2015).

The Crisul Repede Gorge is represented in terms of population by 7199 inhabitants, 3543 women, 3596 men, belonging to two territorial administrative units, namely Suncuius (3147 inhabitants) and Vadu Crisului (3992 inhabitants) (INS, 2019).

For most of these inhabitants the work of the land is the only source of income, despite the fact that the share of arable land in the total land is low (16%, 2283 ha, of which 1016 in Suncuius: 1267 in Vadu Crisului), and, from a pedological perspective, these they do not constitute valuable agricultural land. On the other hand, the high share of pastures and meadows (43%, 6262 ha, of which 3526 in Suncuius: 2736 in Vadu Crisului), which could be a very valuable base for launching animal breeding and capitalizing on animal products (INS, 2014).

The local economy is marked by the loss of the most important activity generating income and creating jobs, the mining company in Suncuius. Currently, Former Mining Exploitation Șuncuiuș is part of the group of companies Bega Minerale S.A. from Timisoara, which is currently exploiting clay. In the locality there are 26 other economic agents, all with wholly private capital, carrying out their activity in various fields, such as: trade, production (bakeries, detergents and cleaning products, food) or services.

Tourism in the Crisului Repede area is represented by the existence of 5 accommodation structures, respectively 184 accommodation places.

The analysis of arrivals at the level of 2018 highlights 3591 arrivals (3091 in Suncuius: 500 in Vadu Crisului), divided into typological categories as follows: in hostels (1200 arrivals in Suncuius), in student camps and preschools (1090 arrivals, in Suncuius) and in Agrotourism pensions (1301 arrivals, of which 801 in Suncuius: 500 in Vadu Crisului) (INS, 2018).

The analysis of overnight stays at the level of 2018 highlights 9564 overnight stays (7331 in Suncuius: 2233 in Vadu Crisului), divided into typological categories as follows: in hostels (2945 overnight stays, in Suncuius), in student camps and preschools (3257 overnight stays, in Suncuius) and in Agrotourism pensions (3362 overnight stays, of which 1129 in Suncuius: 2233 in Vadu Crisului) (INS, 2018).

[3] *http://alpinismbihor.ro*

The analysis of the tourism situation in the area related to the Crisului Repede Defileu shows us that, at present, although there are numerous tourist activities, in the economy of the area, tourism does not play a very important role, despite the numerous natural and anthropic resources with a high tourism potential. The tourist activities that take place in the area, although in full development, do not yet capitalize on the true capacity and value the natural and cultural-historical heritage of the Crişului Repede Gorge. Abandoned tourist infrastructure such as the Vadu Crişului stop, the Vadu Crişului cabin, the restaurant in Șuncuiuș in the Unguru Mic cave area are testimonies of a difficult period characteristic of the two decades that followed the events of 1989, when the economic problems of the area faced with the cessation of industrial activities marked tourism in the area of the gorge. Thus it is imperative to develop a development strategy in which tourism is given due importance.

ENVIRONMENTAL ACTIONS

Tourism, viewed as an economic activity, has both positive and negative influences on the environment. However, we believe that, given the existence of a concrete strategy to capitalize on the strengths of an area in accordance with the principles of sustainable development, the impact on the environment will be positive. This implies ensuring the balance between the economy, society and the environment, thus "tourism, under the conditions of an organized, rational exploitation, does not destroy its own resource" (Cocean 1995, p. 10). Tourism can provide the motivation for a clean environment. This is possible by managing the pollution of water, air, soil, as well as by increasing the aesthetics of the environment through landscaping programs (Herman, 2009; Herman et al., 2019a).

The protection of natural areas can also be a positive impact of tourism, by establishing the protected area regime, being a recognition of the invaluable value that nature concentrates in certain areas. Crișul Repede Gorge is a protected area of national interest included in the 4th IUCN, being a mixed nature reserve. The surface of the reserve is 219.70 ha representing floristic importance due to the presence of vascular plants: species of cormophytes, fern, equisetatae species (horse tail), faunal importance by the presence of species of mammals wolf, deer, wild boar, foxes, rabbits, birds and fish, geological importance due to the limestone in the gorge and the caves included in the reserve over which the site of community importance ROSCI0062 Defile Crisului Repede - Pădurea Craiului, with an area of 40,270 ha. Natura 2000 sites aim not only to protect nature, but also to maintain long-term natural wealth, to ensure the resources needed for socio-economic development (Herman et al., 2016a, b; Ilieș et al., 2015; 2017; Tătar et al., 2017; Wendt et al., 2019). "When defining these sites did not start from the idea of strict protection, which would prohibit human activity. On the contrary, it is considered that in many situations human activities of natural resource management can continue. In many cases the presence of habitats and species in Natura 2000 sites is due in particular to the way in which forests, pastures or grasslands have been managed for hundreds of years".[4] Activities such as traditional agricultural ones, such as growing and obtaining organic products - vegetables, fruits, dairy products, meat, fruit juices, hunting and fishing activities, can and should continue due to their contribution to the diversification and completion of the tourism offer.

The protection actions include specific projects such as the Conservation of bat species in the Pădurea Craiului, Bihor and Trascău Mountains, LIFE08 NAT / RO / 000504, co-financed by the European Union through the financial instrument LIFE + Nature and Biodiversity, carried out between 2010-1013. Following its implementation, the visit routes were changed to bypass the sensitive areas in the Vadu Crişului Cave with important bat colonies, but with high tourist flow the conditions of artificial lighting were changed, the wastes were eliminated, the panels were placed warning in frequented areas or at the entrance.[5]

[4] *www.emenatura2000.ro*
[5] *http://apmbh-old.anpm.ro/Mediu/Programe,%20Proiecte,%20Relatii%20internationale-134*

The Center for Protected Areas and Sustainable Development Bihor (CAPDD Bihor) has proposed to maintain or improve the conservation degree of the bird species of conservative interest and their habitats, in the area between the Defile Crisul Repede and Valea Iadului, the area designated as Site of Avifaunistic Protection (ROSPA 0115 Crișul Repede - Valea Iadului Defileu) within the project Improving the state of biodiversity conservation in ROSPA0115 (2017-2020). Within the project, biodiversity assessment studies will be prepared, mapping of the distribution areas for the species of birds of community interest and their habitats will be carried out and measures will be established to maintain or increase the conservation degree. The proposed activities also aim to diversify tourist activities, as a viable alternative to the sustainable development of the area. This will be done under the conditions of applying an adequate visitor management, able to ensure the preservation of the environmental characteristics that determine the tourist value of the area itself. [6]

One of the most important projects for the supervision and management of waste was initiated and approved by the Bihor County Council through the Bihor Destination Management Agency. The project Implementation and installation of a surveillance system to monitor the areas where waste is dumped illegally during Crișul Repede is an important step towards supporting the tourist activities from the visible gorge marked by the accumulated waste in the waters of Criș Repede due to waste management problems in the localities.[7] It is obvious here the positive role of tourism and the repeated warnings of tourists in the area of Crișul Repede Defile. This surveillance measure should be duplicated by measures aimed at educating, empowering and managing waste at the level of local communities in the defile area.

CONCLUSIONS

Tourism in the area of Crișul Defede Defile is defined by: the level of development of the tourist infrastructure although in development in the last years it offers still reduced possibilities of exploiting the tourist potential of the gorge where the seasonal character of the tourist activities which makes it not an activity basic to ensure permanent character gains, the flow of uncontrolled tourists, the existence of unmanaged caves, thus open to tourism with the risk of their destruction, the existence of the risk of alteration or degradation of habitats.

Currently, the region is carrying out projects aimed at preserving and promoting heritage, protecting and conserving biodiversity, and supporting sustainable tourism development, some funded by the County Council, others funded by European programs. It should also be mentioned the partnerships of local NGOs with results of successful examples.

In support of the sustainable development of tourism in the Crișul Repede Gorge, local authorities should consider a strategy that aims to extend the tourist season, to conserve the natural environment and to promote the objectives with tourism potential. Also for effective management of the area, information and awareness-raising actions are needed among the local communities, in conjunction with the mapping of the protected area, so that there is a database on the plots and the modalities of their use. Information and awareness of the owners regarding the use of the land, the allowed economic activities, as well as the idea of generating sustainable activities, will have a positive impact on the environment in general and biodiversity in particular.

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[7] *https://www.transilvaniabusiness.ro/2019/11/13/defileul-crisului-repede-supravegheat-si-monitorizat-cu-22-de-camere-video/*

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INFLUENCE OF AIR TEMPERATURE AND PRECIPITATION ON THE MAXIMUM FLOW IN THE UPPER BASIN OF THE CRIŞUL NEGRU

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Abstract: The present paper presents the influence of the main factors that generate the maximum flow in the upper basin of the Crisul Negru river. Starting from the three types of flow in the basin (maximum, average and minimum) and selecting among them the most representative from the hydrological point of view - the maximum characteristic leak, data from meteorological and hydrological observations have been used since the 1950s. Characteristic and important, for this type of flow in the basin, are the data collected from the main gauging stations in the catchment area of the upper reception basin of Crişul Negru. Within the paper are presented and analyzed the main elements of the maximum leak as well as the meteorological data recorded in the receiving basin taken into consideration. The characteristic elements of the flow in the riverbeds - flows, levels, hydrological parameters, as well as the determining elements in the formation of the flow - air temperatures and precipitation are taken into account. On the basis of the data processed, analyzed and graphically represented in various forms, the close connection between all these generating elements was emphasized and in some cases they maintain the maximum flow type in the reception area of the upper Crisul Negru basin.

Key words: water level, water flow, maximum flow, precipitation, temperatures, flood

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INTRODUCTION

The present paper aims at highlighting the relation between the maximum flow characteristics and the main climatic parameters in the upper basin of the Crişul Negru. For the proposed purpose, statistical series of historical climatic and hydrological data were analyzed.

For the considered area the existing works are relatively few in number and they treat restricted territorial segments, the studies being developed for reception sub-basins and they

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punctually treat the characteristics of the elements under discussion (hydrological parameters and climatic characteristic). The present paper uses data strings for long periods of time and by this, it is possible to accurately highlight the characteristics of the maximum flow depending on the direct influence of the climatic factors in an extended time unit. The lack of data on hydrological and climatic parameters for longer periods of time (monitoring points established after the 1980s) makes that, in the past, the approach of the problem of maximum flow in the studied area to be unattainable or slightly unpleasant. In the context of the current development, as well as in the context of the most efficient management of the existing water resources (Dumitru and Gale, 2013; Gleick, 2002; Herman, 2009; 2010; Herman et al., 2019a; Loucks, 2000; Nistor et al., 2012), the present work aims to highlight the interdependence of the flow and feeding factors with the direct natural factors related to the propagation and maintenance of the maximum flow phenomena.

According to the Framework Directives of the European Union in the field of legislation regarding the management of existing water resources in the context of preventing and eliminating the risks of producing extreme flow phenomena with mostly negative repercussions, the present study aims to highlight the impact of existing climatic phenomena on maximum flow in the receiving basin. Changes in the manifestation of the meteorological factors at present (strong convective rains with immediate impact on the leak, drought phenomena accentuated, as well as the diminution of the underground supply due to the marked decrease of the water reserves, cause that, at present, the manifestation of the phenomenon of maximum flow suffers changes in those concerning the quantitative character, the frequencies of production and the type of manifestation in the unit of time. Thus, the importance of the present study is justified in the context of the existing climatic changes as well as in the context of the permanent needs of adaptation to the manifestation of the phenomenon of maximum flow in order to avoid imminent risks generated by the presence of the high waters and floods in the upper basin of Crişul Negru River.

The main elements of interdependence are analyzed and represented in terms of maximum flow, both hydrological data on the flow in the basin, data on flowing elements in riverbeds, as well as meteorological data - temperatures and precipitation.

The Crişul Negru river, together with the Crişul Repede river basins, Ier and Barcău (in the north) and Crisul Alb (in the south) form the hydrographic area of Crişuri (figure 1), which drains the western part of the country before it flows into Tisa on the territory of the Hungarian Republic. The water catchment limits of the Crişul Negru basin are: in the north - the Crisul Repede river basin, in the south - the Crisul Alb river basin, the Somesul Mic basin on the east, and the border with the Hungarian Republic to the east.

On the territory of our country the Crişul Negru has a basin of 4237 km², draining the western slopes of the Bihor and Vlădeasa Mountains, the Pădurea Craiului Mountains in the north, and to the south and southwest receives tributaries from the Codru-Moma Mountains. The piedmont hills associated with them have an important contribution to the surface water genesis, which concentrically converge to Beiuş large depression. The hydrographical basin of the Crisul Negru is characterized by a more pronounced density of the hydrographic network in the upper part of the river, then, in the middle and lower part it will gradually diminishes.

From a hydrographic point of view (flow characteristics, annual regime, response time to climatic factors) and morphological (average altitude of basins of tributaries, relief / river slope and slopes, characteristics of the minor and / or major riverbed and tributaries of the Crişul Negru basin can be divided into three sectors or segments: the upper basin (figure 2), with the area of 940 km² (according to the Atlas of the Water Cadaster in Romania, 1992), which is considered for the present work as an extension from the river springs Crişul Negru to Beiuş Depression (near Beiuş), the middle basin, with a surface of 558 km², which runs from Beius town to the Borz-Soimi Gorge - considered epigenetic and antecedent (Berindei, 1977) and the lower basin with a fairly significant extension (2829 km²), from the exit from the Borz-Soimi epigenetic area to the influence with Crişul Alb on the territory of the Republic of Hungary.

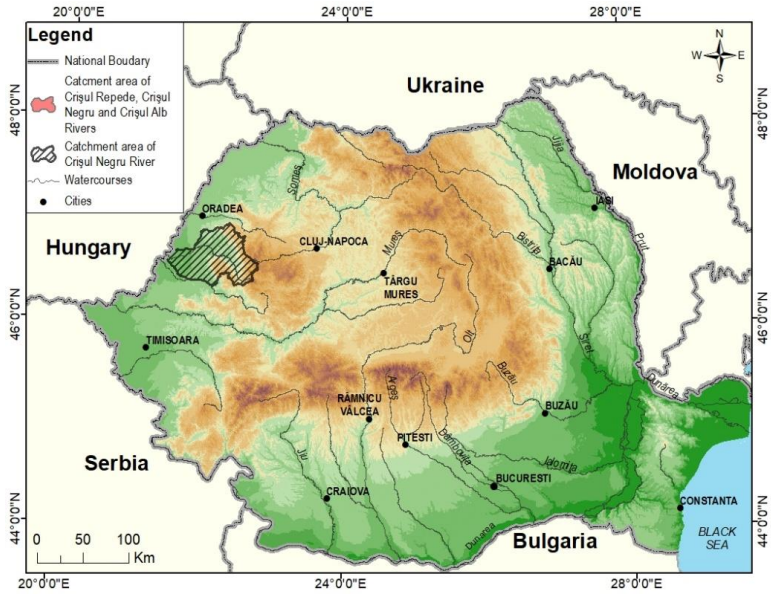

Figure 1. Geographical location, boundaries and hydrographic network in the basin of Crisul Negru

The maximum altitude of the study area is 1694.30 m (Cârligatele), and the minimum one registered at Beiuş (at the Beiuş gauging station) is around 180.00 m M.N. The mean altitude of the upper boundary so delimited is 581.00 m.

The main tributaries of the Crişul Negru River are: Crişul Nou (Oproaia), Crişul Băiţa (with its tributary Sighiştel), Valea Neagră, Crăiasa and Crişul Pietros (formed by the confluence of the Boga rivers and the Galben valley, draining the Padis plateau) from the Bihor Mountains area and the piedmont hills; from the piedmont hills of the Vlădeasa Mountains: the rivers Talpe, Mizieş, Nimăieşti with its tributaries Burda and Beiuşele; from Codru-Moma Mountains receives the left tributaries of the Tărina Brook, Briheni, Valea Mare and Tarcăiţa. All these tributaries with the associated reception basins contribute differently to the collector supply (quantitative but also as the maximum flow distribution time), depending on the hydrological regime dictated by the morphological characteristics and the predominant supply type, maintaining a constant and rich flow to the main collector.

From the climatic point of view, the study area is part of the Pannonian temperate climate, with continental and weak Mediterranean influences (The hydrological Monograph of Crişuri basin, 1968).

The position within the country, towards the Carpathian arch and within the Crişul Negru Basin, as well as the morphological characteristics (the altitude and the deployment in the relief units, the orientation of the peaks and the valleys, the opening of the depression area to the northwest, the radial and convergent character of the valleys to the low, depression area) influence the atmospheric air circulation, imposing, on the one hand, the vertical climatic zone (NAM, 2008), and on the other hand, azonal features such as the sudden temperature increases in January- February or the same sudden falls from October to November. In the upper basin of Crişul Negru the average multiannual average temperature is 9.5˚C and its variation is based on the altitude elevation from 8.0˚C in the mountain area to the average values of 11.0˚C in the low depression area. The average multiannual rainfall is 1052 mm, in the high zone exceeding the threshold of 1200 mm, then this value gradually drops to 825 mm in the depression. The richest month in rainfall is June, and the month with the lowest rainfall is February (Source: ANAR and Archive of Beiuş Hydrological Station).

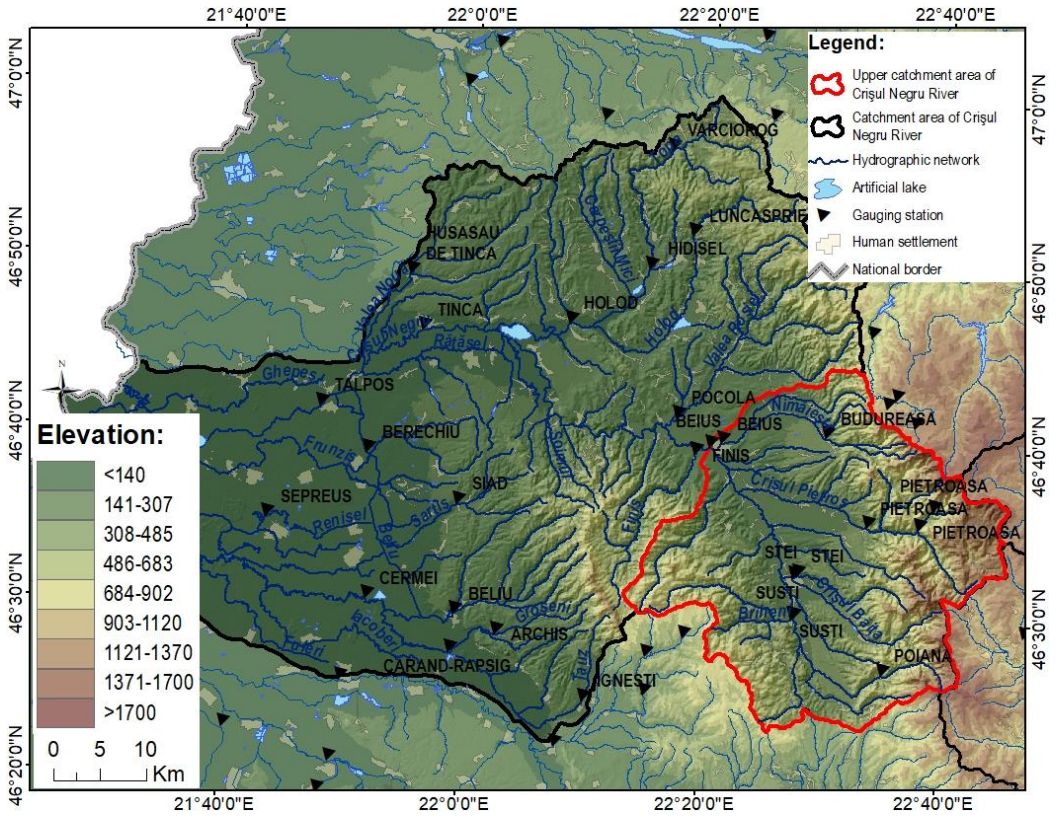

Figure 3. The spatial delimitation, the relief, the hydrographic network and the main localities of the Crişul Negru river basin

DATA AND METHODS

For drawing up this paper, data on the main hydrological and meteorological parameters recorded in the study area were used, so as to highlight the characteristics of the maximum flow in the study area, as well as the influence of the main meteorological factors in generating this type of flow. Hydrological and meteorological data and parameters from the gauging stations located in the upper part of the reception basin were used (hydrographic stations Poiana, Şuşti, Beius, Pietroasa, Beiuş-Nimăieşti, Şuşti-Briheni, Ştei, Sighiştel, Budureasa) from the meteorological stations within its range (Stâna de Vale, Stei, Vlădeasa, Holod, Dumbrăviţa de Codru). The data were extracted and processed from the archive of Beiuş Hydrological Station, through the "Apele Române" National Administration, as well as data from meteorological stations (Stâna de Vale, Stei, Vlădeasa, Holod, Dumbrăviţa de Codru).

The data used are: average and monthly water and water monthly discharges, water levels recorded at the gauging stations in the reception basin, monthly rainfall, and daily average air temperatures recorded at the hydrometric and meteorological stations in the area. The maps were drawn based on vector and raster data sets in GIS (Herman, 2016, 2019b; Ilies et al., 2014, 2016, 2017). For interpolation, the Kriging (Romocea et al., 2018; Dehoorne et al., 2019; Herman et al., 2019c) method was supported by data and values entered into a network of Thiessen polygons. In order to determine the influence of temperature and rainfall on the maximum flow in the upper basin of Crişul Negru, the methods of statistical processing of data strings (descriptive statistics, correlations) and comparative analysis of hydrographs, maximum flow balance as well as analysis of thematic maps generated on the basis of climatic parameter values.

RESULTS AND DISCUSSIONS

The maximum drain in the upper basin of the Crişul Negru. Generating elements and intake in the basin and sub-basins

The entire amount of water that passes into a unit of time through any section of a watercourse is the water discharge at the riverbed and is expressed in m³ / s. In a spatial unit, it can be converted into a specific flow as a ratio between the water discharge and the surface of the basin (expressed in km²), up to a given section. The specific flow is calculated as follows:

$$q(l/s/km^2) = \frac{Q(m^3/s)\times 1000}{F(km^2)},$$

where: q - the specific discharge

Q - water discharge (average, instantaneous, maximum etc.) (m³ / s)

F - the surface of the reception basin for a given section (km²)

When drawing up specialized papers, the difference between the two terms - flow and flow must be taken into account. Flow is the process by which a river's water transits a given section in time, depending on hydrological and hydraulic parameters characteristic of that section. The flow term is used to characterize the flow in a surface unit at a section considered. Starting from this terminology difference in the flow regime of a watercourse, three main phase phases are highlighted: **average, maximum and minimum.**

From a quantitative point of view, the average flow is the period (s) of the year in which the water discharges are around the multiannual values taking into account a long period of time and "is determined on the basis of the measurement of the liquid discharges, by the arithmetic method of their daily, monthly, annual values, for as long as possible" (Pişotă, 2010). Minimum flow or periods of small water is considered when the daily, monthly or annual water discharge rates are well below the multi-annual average.

The maximum flow is the hydrological regime phase in which recorded water discharge significantly exceed the average discharge rates and "is the consequence of the rich supply of snow melting and abundant rainfall" (Pişotă, 2010). However, a clear distinction should be made between **the maximum flow** or the term of **high water** and **flood**. The first represents a high discharge rate in the riverbed in a long time unit and is quantitatively above the multi-annual average discharge rate, or "represents the phases in which daily, decade and even monthly discharges are high, exceeding the discharge rate multiannual environment" (Sorocovschi, 2002). The second represents a sudden increasee of the discharge of a river in a relatively short time, followed by a slower decrease or sometimes as sudden as the generating elements of that flood, or "represent peak moments in the evolution of a river's water flow" (Pisotă, 2010).

In this respect, in the considered area, high waters are rarely encountered due to the morphology of the land, the high relief energy, the slopes of the large thalweg, as well as the relatively small basin areas. The type of West Carpathian regime is characterized by "richer summer flow than winter, underground supply of 40-60% and predominantly pluvial and superficial mixed surface water supply" (Diaconu, 1971). In order to identify the most important episodes of the maximum flow on the collector and its tributaries (quantitatively monitored by hydrometric stations), we have set a maximum delimitation threshold for the annual maximum discharges (table 1) according to the time intervals for which the hydrological data were processed from the hydrometric stations in the upper basin of Crisul Negru.

For the analysis of the maximum flow in the upper basin of Crisul Negru, three major aspects regarding the generation of this flow must be considered: (I) the type of river supply in the reception basin; (II) the spatial distribution of upstream tributaries, as well as the areas drained by them; (III) the main sources of genesis of the maximum flow (climatic, pedological, morphological: relief energy and exposure of the slopes, degree of afforestation, anthropogenic influence, etc.).

Table 1. Gauging stations, morphometric elements of sub-basins and set thresholds (average annual maximum discharges)
Source: ANAR and Archive of Beiuş Hydrological Station

Nr. crt.	The river	Gauging station	Year of establishment	F (km²)	Hmed (m M.N.)	Multiannual average flows (mc/s)	Q MAX. multiannual maximum average flows (mc/s)	Calculation period
1	Crisul Negru	Poiana	1983	29.9	1016	0.958	9.33	1984-2018
2	Crisul Negru	Susti	1950	137	617	2.29	32.9	1955-2018
3	Crisul Negru	Beius	1889	940	581	14.0	225	1952-2018
4	Briheni.	Susti	1978	83	598	1.10	19.0	1978-2018
5	Crisul Baita	Stei	1961	65	796	1.23	23.3	1962-2018
6	Sighistel	Stei	1986	25	589	0.501	9.46	1987-2018
7	Boga	Pietroasa	1986	31.5	1140	1.06	14.5	1987-2018
8	Valea Galbena	Pietroasa	1986	56	988	1.93	23.9	1987-2018
9	Crisul Pietros	Pietroasa	1951	158	972	4.50	68.2	1955-2018
10	Nimaiesti	Budureasa	1982	31.3	752	0.627	13.3	1983-2018
11	Nimaiesti	Beius	1973	108	502	1.74	42.8	1973-2018

From the point of view of the type of feed in the reception basin, most of the tributaries as well as the collector have a predominantly superficial (pluvial, flood and pluvio-nival) supply, the underground supply being quite low. The Western Carpathian type of supply is characterized by partial melting in the winter, followed immediately by high spring waters, after which the flow decreases until early summer when the summer floods occur" (Diaconu, 1971). The exception is the tributaries that have their origin in the karst area, where the underground supply is predominant, with the transfer of water from one basin to another (Bogă, Galbenă Valley, Crişul Pietros). The water supply of the tributaries of different orders in the reception basin is, in most cases, made in proportion of over 60% of the rainfall or the melting of the snow layer (Diaconu, 1971).

The sub-basins of the main tributaries of the Crişul Negru, by their position within the relief units, as well as through the large flow areas, play a particularly important role in the continuous supply of the collector with constant and quantitative water discharge rates (table 1 - Q average multiannual). As a territorial distribution in the upstream basin, the main tributaries have reception areas located directly in front of the masses of western air penetrating inside the Beius depression to the high orographic units blocking their movement, generating the fall of significant amounts of rainfall, most frequently in the spring and early summer, but also torrential rain episodes during the rest of the year, in special synoptic situations. Thus, through the spatial positioning of these tributaries in the upper basin of Crisul Negru, the flow is ensured throughout the year, the seeping phenomena being recorded only on the third or fourth order tributaries (Atlas of Water Cadastre in Romania, 1992) with their springs at low altitudes, in the piedmont hills.The most important tributaries are Crişul Nou, Crişul Băiţa, Valea Neagră and Crăiasa, then the largest tributary on the right, Crişul Pietros, followed by Valea Talpe, in the order of input to the hydrological polarizing vector of the basin, Mizieş and Nimaieşti. From the left slope, Crisul Negru receives the tributaries: the Carinia brook, Briheni, Valea Mare and Tarcaiţa.

Their contribution to the maximum flow on the Crişul Negru is different, depending on the surface of the basin and their altitude, but also on the climatic factors that generate the production of large waters and floods. The correlation (figure 4) expresses the connection

between the average altitude of the basin and the maximum specific discharge (in whose calculation the basin surface is taken into account) and the contribution of each hydrometric station from the reception basin to the maximum flow. Deviations from this correlation are due to physical-geographic factors (especially reduced basin areas), as well as the specific feeding regime (karst feeding).

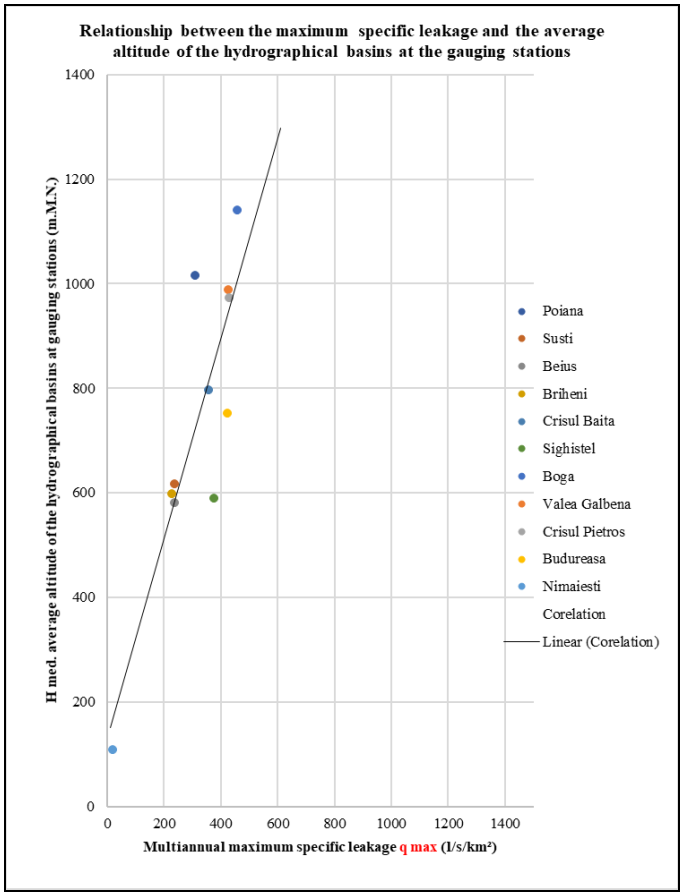

Figure 4. Relationship between the maximum specific flow and the average altitude of the hydrographical basins at gauging stations in the upper basin of Crisul Negru
(Source of data: Beiuș hydrological station archive)

In the upper part of the Crișul Negru reception basin, high waters are rare and the presence of floods with relatively short total times (maximum 8-10 days for a flood) are the flow elements that characterize this type of area. There are different situations from one flood to another or from one pool to another depending mainly on the flow of each. In the recepton basin, there were three types of flood formation that generated maximum flow:

- floods formed in the whole area of the reception basin - these being usually the largest in the basin, the propagation being made upstream upwards, and all the tributaries participate in the genesis (figure 4; Graph1). These may be simple or compound. It can be observed the participation in the formation of the flood wave of all tributaries in the reception basin depending on their reception areas. As a unit of time, flood wave propagation is done in a relatively short time - the order of hours at the top of the basin, with the maximum occurring in the closure section at a maximum of 6-8 hours.

- floods generated only on certain portions or basins of right or left tributary basins, depending on rainfall in separate areas (on the left or right side of collector reception basins) (figure 4; Graph 2). In the closing section, they do not have a particular influence on the achievement of particular discharges, but this is different from one situation to another.

- "flash floods" that occur as a result of strong and point-like rains in a reception basin, which causes sudden and rapid increases in discharges, followed by equally rapid drops (figure 4; Graph 3). Typically, convective rains that affect small areas are the ones that lead to the genesis of such rapid floods.

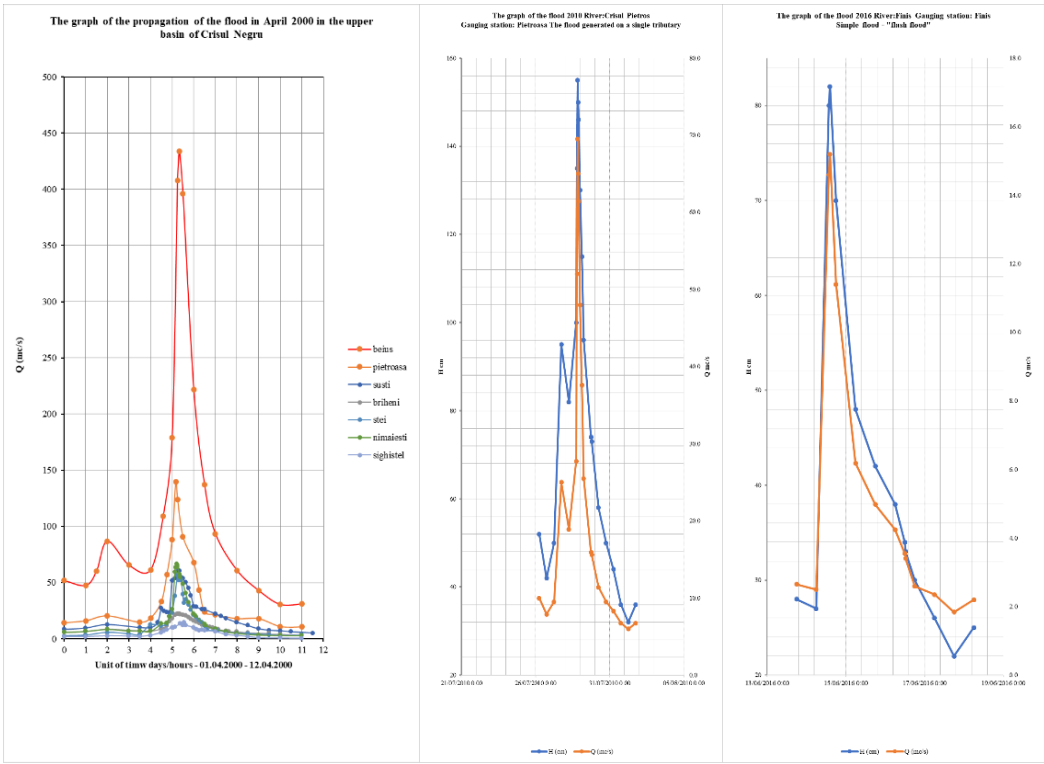

Figure 5. Types of floods encountered in the upper basin of Crisul Negru
Source of data: Beiuș hydrological station archive

Starting from the territorial analysis of the feeding regime, the distribution and the topographical deployment, the influence of the climatic factors on the flow in the upper part of the reception basin of the Crisul Negru is practically the most important for the purpose of the maximal flow genesis. Air temperature and rainfall are the two climatic factors that determine the genesis and maintain the maximum flow or flood in the reception basin.

Air temperature

Due to its influence on atmospheric pressure variations and consequently on the formation of conditions for rainfall (liquid or solid, of different intensities), air temperature and its variability play an important role in determining the type of flow regime of the rivers and in the duration and the main stages of the regimen (high water, small water). On the other hand, during the cold season, the air temperature causes the frost phenomena on the rivers, but also the (slow or sudden) melting of the snow layer, both of which have an impact on the extreme flow (small winter waters or flood and mixed floods). Air temperature plays a role in genesis because, depending on the

temperature and tightness of the pressure generated by the air, the air loaded in various forms of water vapor (clouds) leads to the formation of rain drops by the transition from one state to another of the water in these clouds. Thus, the conditions of rain formation could not be met without the optimum temperature, and basically the feeding of the rivers would not be supported by the main factor of genesis. Air temperature, closely related to solar radiation, favors the degree of evapotranspiration or sometimes in winter, favors the occurrence of frost phenomena in riverbeds and thus, quantitatively influences the flow of water in the riverbeds.

From the point of maximum discharge, which materializes through the floods in the basin, air temperature can play a triggering factor or stop the evolution of extreme hydrological phenomena, hence the production of large waters or slow floods. Given the existence of a significant layer of snow, there is the possibility that, under fast-moving high temperatures, it may suddenly melt and generate slower or faster floods, depending on the melting phenomenon.On the other hand, in the comparative analysis of the data strings, numerous cases of generalized floods on the basin, generated by large amounts of liquid front precipitations, have been identified and "quenched" by their transformation into solid precipitations due to the sudden decrease of the air temperature.

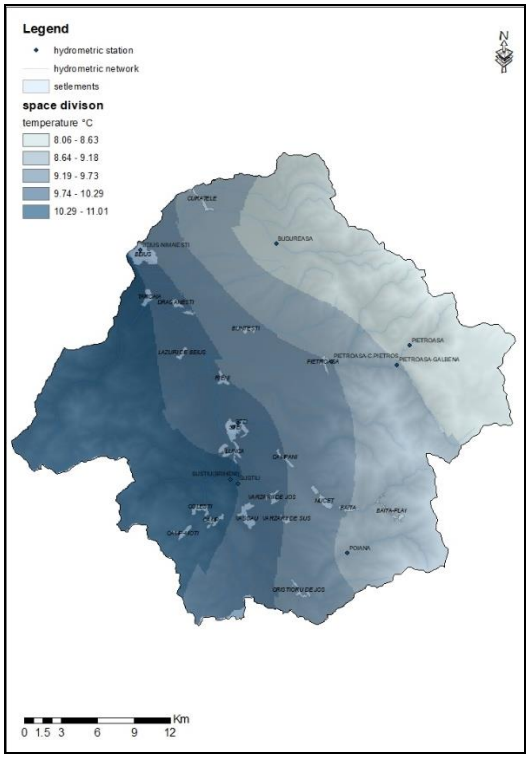

Figure 6. Space distribution of the air temperature (multiannual average) in the upper basin of the Crişul Negru
Data source: "Apele Romane" National Administration

The distribution of air temperature (Figure 6), as multiannual values per supply sector in the reception basin, results in a differentiation of the flow from the high to the lower altitudes, in that, in the high zone during the winter, the flow is deficient due to negative temperatures (which act as a quantitative flow factor), thus lack of rainwater supply. The installation of frost phenomena in riverbeds, as well as the transformation of liquid precipitation into solid precipitation, with the storage of a significant amount of water in the form of a snow layer, is a

genetic factor in the flow and propagation of floods or upstream large downstream waters. In this case, it is the temperature of the air that determines the flow regime of rivers in early winter and spring, depending on the melting time of the snow layer.

Rainfalls

The upper basin of the Crişul Negru is located in the direction of the western wind masses penetrating into the Beiuş depression, where they hit the horizons of the mountains surrounding the reception basin, then "go upward, cool adiabatically until the dew point temperature is reached, and then generate significant quantities on the western slopes" (Gaceu, 2005). Thus, the altitude steps determine the amount of rainfall (figures 7, 8) that is unevenly distributed with a significant increase from the low slope to the high mountain range.The distribution of precipitation amounts is gradual from 800-950 mm annually in the depression area of Beius, 950-1100 mm in the piedmont hill area and over 1100 mm in the mountain area of Bihor-Vlădeasa and Codru-Moma massifs.

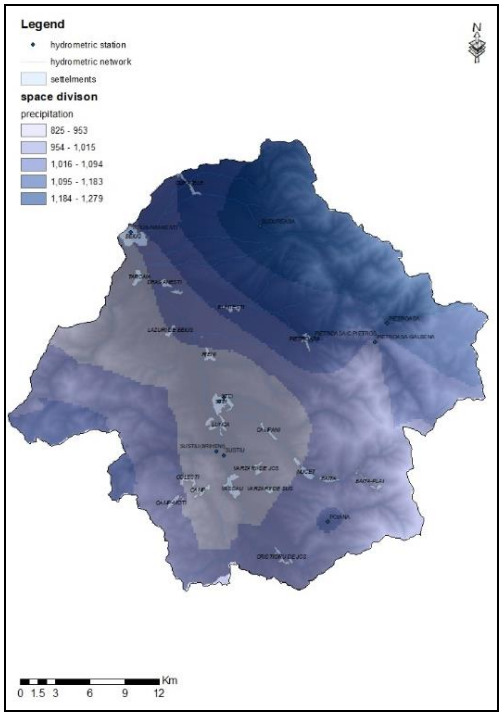

Figure 7. Spatial distribution of the multiannual average rainfall (mm) in the upper basin of the Crişul Negru
Data source: "Apele Romane" National Administration

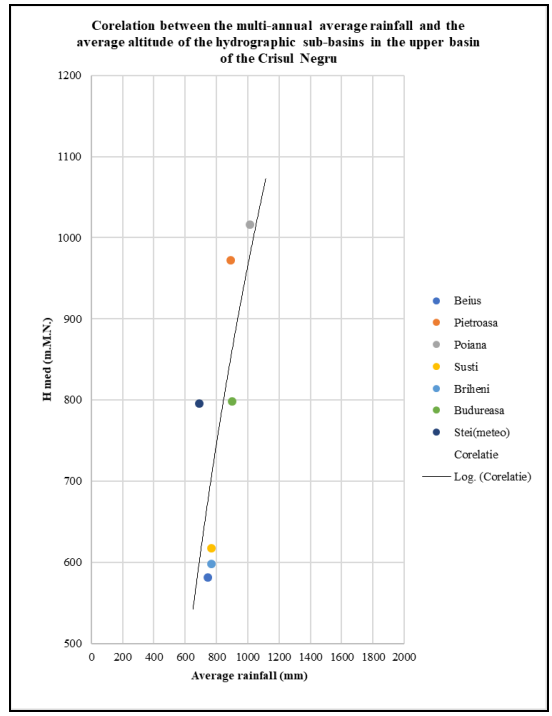

Figure 8. Correlation between the multi-annual average rainfall and the average altitude of the hydrographic sub-basins in the upper basin of the Crişul Negru
Data source: Beiuş hydrological station archive

High waters basically represent that type of flow discharges and elevated levels in sections of riverbeds that are maintained over long periods of time from two sources: or melting of the snow layer in the upper parts of the reservoir, often accompanied by liquid precipitation, or by low-intensity front rains in the area, but which are maintained for a long time in the reception basin and which accumulate in a long unit significant amounts of precipitation.

They can stretch over long periods of time (for days), and after the soil is completely or oversaturated, the entire amount of rain falling to the riverbeds.

As a result of the analysis of hydrographs of the maximum water flow in the basin, both for the Beius gauging closure station (figure 9) and for those on the main tributaries, a close correlation can be noticed between the maximum flows recorded in the basin and rainfalls that are the main source of water supply in the area. Depending on the basin surface, as well as the physical-geographic position and geological characteristics of the respective sub-basins, the contribution to the maximum flow is different by the rapid or delayed "response" to the amounts of rainfall fallen into the surface unit. Rapid summer floods can occur due to convective rains or slow and “heavy” floods that stretch over long time units for both growth and downtime.

The time segment analysis of the maximum water flow hydrograph at the Beius gauging station leads to a clear reality of interdependence between maximum flows and maximum annual rainfall. Significant increases of the rainfall amount in the basin lead to two types of river bed response: in summer, although the amounts of precipitation are marked, flows have a slower growth trend due to the soil conditions as well as the presence of vegetation developed in the feed areas that have the role of rainfall, whereas during the winter and spring the rainfall quantities are not retained in the soil or in the vegetal and arboreal carpet - this leads to more significant increases in the flow.

Table 2. The absolute frequency (number of values) and the percentage (%) of the maximum annual discharges, respectively the maximum monthly discharges higher than the average annual maximum discharges due to pluvial supply and the mixed supply (floating, pluvio-nival or nivo-pluvial) in the upper basin of the Crişul Negru

Data source: Beiuș hydrological station archive

Nr. crt.	River	Gauging station/ Average annual max. flows	F (km²)	Hmed		The absolute frequency (number of values) and the percentage (%) of the maximum annual flows		Number of values	Years
						V-X (Pluvial supply)	XI-IV (Mixed supply)		
1	Crisul Negru	Poiana	29.9	1016	Frequency annual Q max (%)	54.3	45.7	35	1986-2018
		9.33			Frequency Q max > Average Q max (%)	62.5	37.5	16	
2	Crisul Negru	Susti	137	617	Frequency annual Q max (%)	40.6	59.4	64	1955-2018
		32.9			Frequency Q max > Average Q max (%)	40.7	59.3	27	
3	Crisul Negru	Beius	940	581	Frequency annual Q max (%)	43.3	56.7	67	1952-2018
		225			Frequency Q max > Average Q max (%)	51.9	48.1	27	
4	Briheni	Susti	83	598	Frequency annual Q max (%)	29.3	70.7	41	1978-2018
		19.0			Frequency Q max > Average Q max (%)	12.5	87.5	16	
5	Crisul Baita	Stei	65	796	Frequency annual Q max (%)	59.6	40.4	57	1962-2018
		23.3			Frequency Q max > Average Q max (%)	66.7	33.3	18	
6	Sighistel	Stei	25	589	Frequency annual Q max (%)	46.9	53.1	32	1987-2018
		9.46			Frequency Q max > Average Q max (%)	66.7	33.3	12	
7	Boga	Pietroasa	31.5	1140	Frequency annual Q max (%)	46.9	53.1	32	1987-2018
		14.5			Frequency Q max > Average Q max(%)	64.3	35.7	14	
8	Valea Galbena	Pietroasa	56	988	Frequency annual Q max (%)	37.5	62.5	32	1978-2018
		23.9			Frequency Q max > Average Q max (%)	35.7	64.3	14	
9	Crisul Pietros	Pietroasa	158	972	Frequency annual Q max (%)	50.0	50.0	64	1955-2018
		68.2			Frequency Q max > Average Q max (%)	58.3	41.7	24	
10	Nimaiesti	Budureasa	31.3	752	Frequency annual Q max (%)	44.4	55.6	36	1983-2018
		13.3			Frequency Q max > Average Q max (%)	73.3	26.7	15	
11	Nimaiesti	Beius	1973	108	Frequency annual Q max (%)	56.5	43.5	46	1973-2018
		42.8			Frequency Q max > Average Q max (%)	58.8	41.2	17	

The frequency of high water production and floods in the considered area can be analyzed in table 2, where it can be seen that the types of food vary from season to season depending on seasons of the year (pluvial or mixed feed). The weighted distribution of the production frequencies is somewhat balanced in terms of the time distribution of the occurrence of the maximum flow phenomena. In addition to the climatic genetic factors, the physical-geographic, pedological, geological and also anthropogenic factors occur in the time distribution of the production mode in seasonal unit and depending on the types of feeds of these rivers that are part of the flow at the upper basin of the Crişul Negru.

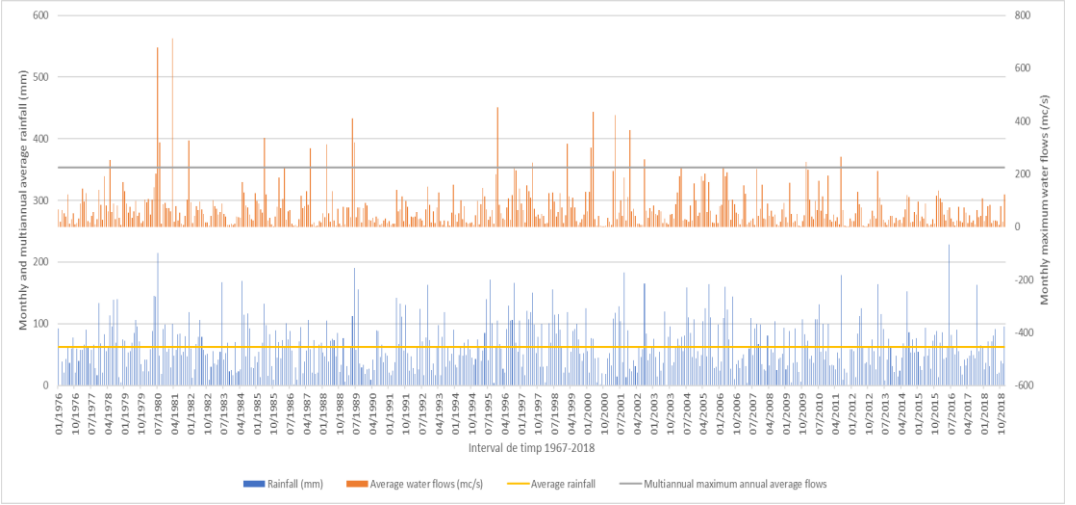

Figure 9. Monthly maximum water discharges (and multiannual maximum annual average discharges), monthly and multiannual average rainfall at the Beiuş gauging station on the Crişul Negru River
Data source: Beiuş hydrological station archive

CONCLUSIONS

Several aspects can be concluded by analyzing the data strings used, the maps, the graphs that were plotted, the correlations as well as the centralized tables with processed values:

a) high waters are reduced as frequency due to flow conditions in riverbeds - high slope, relatively small reception areas, short distance between the hydrographic closure node and the points in the basin where the flow forms;

b) all physical-geographic, spatial-temporal, geological, pedological and anthropogenic factors play an essential role in the formation and sometimes the maintenance of high waters and floods in the upper reception basin of the Crişul Negru river;

c) the quantitative distribution of multiannual precipitation in the Crişul Negru upper reception basin, as well as the decrease of the multi-annual average temperatures of the air, are closely related to the elevation of the relief. This plays a special role in the flow in the basin of each tributary with the associated reception basin;

d) the decisive factors in the process of feeding and maintaining the maximum flow are air temperature and rainfall. The temperature directly conditions rainfall formation and plays a role in the distribution over time of the quantitative flow parameters in the riverbeds.

Precipitation is directly responsible for the flow types throughout the basin reception area and dictates overwhelmingly about their feeding regime. The interdependence of the two factors is felt in all that means the formation and maintenance of the maximum flow at the level of the entire upper basin of the Crişul Negru.

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POIANA RUSCĂI: ONE MOUNTAIN AND TWO MONUMENTS

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Abstract: A subunit of the Romanian Western Carpathians, Poiana Ruscăi Mountains are considered a complex with a medium concentration of tourist, natural and anthropogenic resources "National Territorial Plan, Section VI - Areas with tourism resources", but on this background, some outstanding tourism resources stand out, that is the two monuments from the early twentieth century dedicated to tourism, one from 1914 in Timiş County (common Nădrag), the other from 1936 in Caraş-Severin (commune Rusca Montană). This year marks the 105th anniversary of the edification of the Nădrag monument.

Key words: Poiana Ruscăi Mountains, Nădrag Tourist Monument, tourism resources, local economy

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INTRODUCTION

The relief is a first-rank element in shaping the tourism potential of a region, while also representing the support for all activities in the sphere of tourism. Of all the typologies that the relief has, no one gives the tourist the feeling of greatness, of freedom, of wildness, of loneliness deeper than the mountain (Blasco et al., 2013). Due to the very large spatial extent of the mountain areas, occupying about 24% of the planet's land, and the relatively homogeneous distribution within the continents, the mountain spaces are required to be very frequented by tourists (de la Cruz del Rio-Rama et al., 2018).

Mountain tourism is one of the most developed branches of this phenomenon (Brătucu et al., 2017), having a high economic profitability and folding on a wide typology of tourists (Kuscer et al., 2016; Herman et al., 2017). The mountain landscapes by their intrinsic value, the nature least disturbed by the human intervention that characterizes the mountainous areas and the varied opportunities for leisure (Herman et al., 2019; Nepal, 2002; Beza, 2010; Boller et al.,

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2010; Ilieș et al., 2017a; Ilieș et al., 2018), attract as a magnet a very large number of tourists from all over the world (Vujadinovic et al., 2013). Contributing with about 15-20% annually to global tourism and making up to $ 90 billion in revenue each year (Mohd Taher et al., 2015), mountain tourism is the second type of tourism in terms of profitability, after the coastal turism.

Romania is a country with a strong tourist vocation, due to the great diversity of the relief and the unique material heritage created over the centuries by the romanian people (Cocean, 1998). And due to the approximately 28 percent of the total area of the country occupied by the Carpathian Mountains (Ilieș et al., 2017b), it is identified as one of the important destinations for mountain tourism at European level.

Poiana Ruscăi Mountains are a subgroup of the Western Romanian Carpathians (Ancuța et al., 2012), which due mainly to low altitudes, do not stand out for their first rank tourist attractions, as compared to major relief units of the Romanian Carpathians. It is a less tourist promoted area, but which it also has a complex potential to be noticed due to the petrographic structure that gives rise to a diversified relief (volcanic, limestone, etc.), but also due to the numerous records of the habitation of these lands since ancient times. which are still preserved today as archaeological sites (Ciorogariu, 2009). The Poiana Ruscă mountains have been over time research subject for numerous scientific studies (Toma and Lincă, 2013; Dobra et al., 2018; Chirilă et al., 2018; Golosie and Baliga, 2010) which were focused mainly on determining the tourism potential of this region and identifying new ways to promote it.

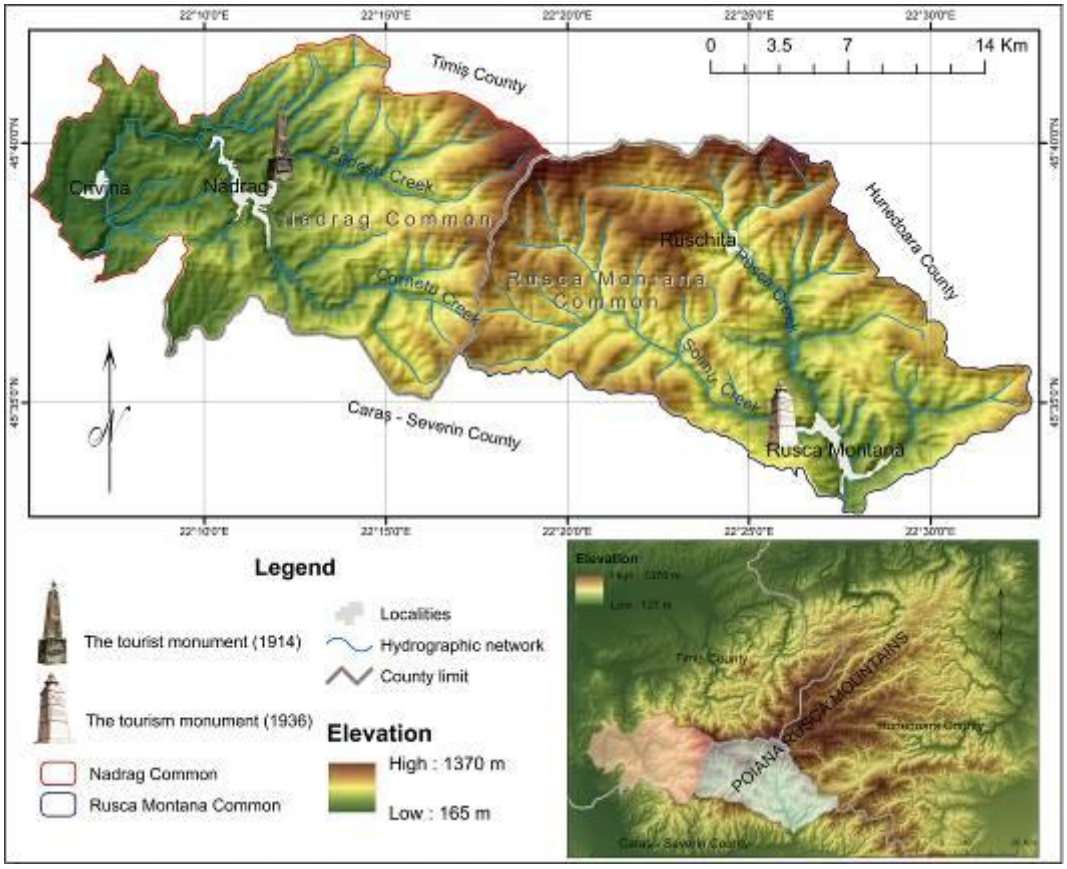

Figure 1. Geographical location of the two monuments in Poiana Ruscăi Mountains

As was shown above, there is no mountain unit that does not have its own resources with tourist attraction attributes. It is up to us whether and how we capitalize these resources and turn them into tourist attractions. Among the numerous anthropogenic attractions of Poiana Ruscăi Mountains (Ciorogariu, 2011), in this study we discuss about the two monuments dedicated to tourist / tourism and the implications they have on local communities and tourism development in the region (Herman, 2012; Herman and Benchiș, 2017; Herman et al., 2018). It is about two monuments in two neighboring communes, which belonging to different counties: the monument on the Cireșului creek, in Nădrag (Timiş county) and the marble monument from Ruschiţa - Rusca Montană (Caraş-Severin) (figure 1).

MATERIAL AND METHOD

Field study is the main tool we have used since there are no written documents in this regard, only oral stories that altered over time (there are less and less locals who lived in the early twentieth century and had direct contact with its realities). We turned to such elements of oral history ("life stories",„récit de vie", "family history"- Ştiucă, 2006) and memories of Auntie Esterle Aurora (named Oronko) who worked at the cottage "Pescărie" (at the time when i used to stop there on my way home from school, but also later on, after going to the university) and those of my father's Imi Linc, who lived his childhood and youth "two steps" away from the cottage "Pescărie" and with the "forest train" passing by his family home. At the same time, ArgGis 10.6 and 3D Map Generator were used for mapping, and image processing was done in Adobe Photoshop CC 2015.5.

RESULTS

105th anniversary - Nădrag Tourist Monument

Back when tourism was merely a concept in our country, being anyway the prerogative of the rich, back when local people were working hard in steel industry (back then "The Iron Industry in Nădrag" - Linc et al., 2008) to earn their daily bread, in Nădrag village on the Cireș creek (a tributary of Padeşului valley), in the year of grace 1914, in cottage "Pescărie", located on one of the major access routes to the Pades Peak (this route isn`t used anymore, it`s barely known), lived Jahn Volgy, a passionate hunter and well acquainted to these lands, in charge of Nădrag forests.

We learned that Jahn Volgy, probably wanting to highlight the beauty of nature but also to leave a written record of his existence, engaged in erecting an unusual monument on this pathway to the heart of Poiana Ruscăi Mountains and stand there over centuries as a witness. Thus appeared the oldest monument in the country dedicated to the tourist, on which some verses in Hungarian are inscribed (figures 2, 3, 4), signed Jahn Volgy, 1914.

"HA AZ UTAD ERRE VEZET,
ÉLVEZNI E KIES HEYLET,
BORITSD FÁTYOLAL A GONDOD,
MERT KI FELED, AZ A-BOLDOG".

Located at an altitude of 350 m, the monument itself consists of three concrete blocks with the shape of a pyramid 3,20 m high, a 70 x 70 cm base and a 40 x 40 cm top. In its middle there is a bronze plaque which has inscribed the words above on. The monument does not mention explicitly if it is dedicated to the tourism or the tourist, but because it has a human figure in bronze with a backpack on top (figure 2), image that today is associated to a tourist who goes to the mountain, we may say that ... it is a monument dedicated to the tourist. Jahn Volgy is buried in Nădrag, in the old cemetery (called the "German Cemetery"), but nobody knows exactly where, as a part of the cemetery is overgrown with woody vegetation. After the death of Jahn Volgy, in the turbulent times that have succeeded over the twentieth century (the two world wars, changing political regimes), in an almost perpetual poverty, the people have slowly forgotten about this monument. Nestled at the base of the left slope of a valley which entered into obscurity after ceasing extraction of iron ore from Dâmbu cu Fier (not far from Padeş Peak), without any resonance echo today (Cireşului creek), although very old, not much is known

even in Nădrag about this monument, and many locals just know that it is somewhere on the "the Padeș" (meaning Padeşului Valley), not far from the "Pescărie".

Figure 2. The Tourist Monument on Cireşului creek (right) and the translation of these lyrics (left)
(photo: Nelu Balaş)

Figure 3. The lyrics in hungarian call at enjoying the beauty of the places
(photo: Nelu Balaş)

Figure 4. The year of raising this monument
(photo: Nelu Balaş)

In childhood (ie 40 years ago), my father Imi Linc used to tell us about "Monument", but he never took us there, saying that the forest grew over it.

No indicator anywhere, no visible sign of existence speak of this old monument. It is our reliable collaborator Nelu Balaş`s merit (without a doubt, the best knower of the whole massif of Poiana Ruscăi), that after 1990 the existence of this monument was brought to the public (even the locals) this Tourist Monument and ever since he has been desperately trying to insert it in the tourist circuit, often taking there various groups (larger or smaller) of tourists, in this way hoping to promote this objective orally. In the early '90s Nelu together with some friends of his and his brother Tudor "cleared the

"Monument's surroundings and next to it they erected a wooden billboard on which they put a metal sheet (coming from the "Ciocanul" Plant from Nădrag) and translated the lyrics in Hungarian (Mr. Szelle Ladislau) (figure 5) for the visitor to understand the message of their authors over the centuries.

„If in your way you pass through here,
Enjoying these charming places,
Drop the oblivion veil over worries and thoughts,
For only the one who forgets can be happy".

Figure 6. Ensemble "Tourist Monument"
(photo: Nelu Balaş)

Figure 7. Towards the Tourist Monument, on Cireşului creek
(photo: Nelu Balaş)

And to avoid any misunderstanding of the message, on the panel that bears the translated lyrics, Nelu Balaş and his brother Tudor Balaş, specified "The Tourist Monument, 1914". It just seems to be missing the phrase "You, tourist !", followed by the flow of four lines: " If in your way you pass through here ..." (figures 5, 6).

Since translations sometimes give rise to heated discussions, we have asked two opinions on the translation of the lyrics from Mrs. Elizabeth Rozin, teacher and Mr. St. Nistor Lecturer (Hungarian speaking). It can be seen that there are no major background differences, so the 20 year old translation can stay where it is now, that is on the panel next to the monument.

In Romanian	**In English**
Varianta d-nei Elisabeta Rozin	Translation of Mrs. Elizabeth Rozin
Dacă drumul te aduce pe-aici	If your way brings you through here
Să savurezi acest loc,	Savour this place,
Acoperă-ţi necazurile cu un voal,	Cover your troubles with a veil,
Căci cine uită, va fi fericit.	For he who forgets shall be happy.
Varianta d-lui Stelian Nistor	Translation of Mr. Stelian Nistor
Dacă drumul tău ajunge pe aici,	If your way brings you through here,
Să te bucuri de acest loc,	Enjoy this place,
Acoperă-ţi gândul cu o năframă,	Cover your thoughts with a veil
Pentru că fericit este cel care poate să uite.	For happy is he who can forget.

At the present time, the monument is quite degraded, concrete being "pinched" by the action of exogenous factors (much moisture because of its location in the forest, near the bed of a creek, in a narrow, shaded valley) and both the base of the monument and the main body, on which the inscription plate is, are overgrown with moss. This year - 2019 marks the 105th anniversary of the construction of the Nădrag Tourist Monument. The same Nelu Balaş has been struggling to make it known to the world through as many channels of information as possible, but so far there has been no echo from local and regional authorities.

Much closer to the cottage "Pescărie", on the left side of Cireşului Creek, there is another Ruschiţa marble plate (indirectly illustrating the communication between two rural communities: Ruschiţa and Nădrag), installed by the same Jahn Volgy with an inscription on hunting, only the hunters` fervor of the contemporary locals has expanded over it, so it is now all holes after being "hunted" with the rifle.

Compared to Tourism Monument, carved in Ruschiţa marble (which rivals the famous marble of Cararra), the monument on Cireşului Creek impresses not only by design or construction material, but also by its age and the scent of history that it denotes.

Nădrag - Tourist Monument trail on the Cireşului creek

Nădrag commune is linked to the network of settlements outside the Poiana Ruscăi Mountains through the county road DJ 681 (Lugoj - Făget) (from the intersection with DN6 / E70), thus providing communication with the towns Lugoj and Făget. You can get to Nădrag by bus (which has four roundtrip rides a day) leaving from the bus terminal „Atlasib" in Lugoj and its stations in the town (at Parc and Stadium) or by car on the route Lugoj - Caransebeş (E70), from the intersection with DJ 681.

There are three bus stops in Nădrag: the "Red Block", the "Cityhall" and the "Green market" which is the last stop (or most upstream). From the last bus stop the access to the Tourist Monument is very simple and easy.

This monument is at a short distance from the last house in Nădrag (str Padeş, no. 69) (figure 8) (2.5 km) and requires almost no sustained physical effort to reach it, an easy walk is enough (about 30-40 minutes walk). Here ends the freshly paved road of Padeş street and you have to follow the valley upstream on a not long ago forest road (it is now a communal road DC 140!) until you get to the old cottage at the "Pescărie" (in the early twentieth century there really was a trout fishery here, you can still see the old pools overgrown with brambles and bushes).

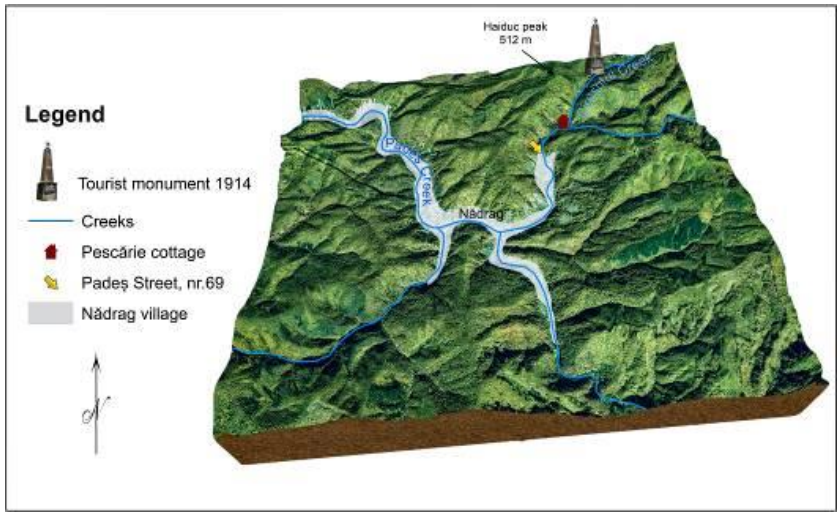

Figure 8. Topographic background

One can also use the old "wagon road" called "the old road" which is on the left side walk upstream on the bank of Pades, past the last house (currently under reconstruction). It has been destroyed on a 10 m length by a slide of the ground covertures on a slope (the story is old, happened about 30 years ago, the rock is now exposed, nothing else happens) but it is interesting because it goes right through the forest and is slightly cooler in summer.

Figure 10. Cottage „Pescărie"on the right bank of Cireşului creek, at the confluence with Padeş
(photo: Ribana Linc)

Figure 11. Nădrag forest nursery on the left bank of Cireşului creek at the confluence with Padeş
(photo: Ribana Linc)

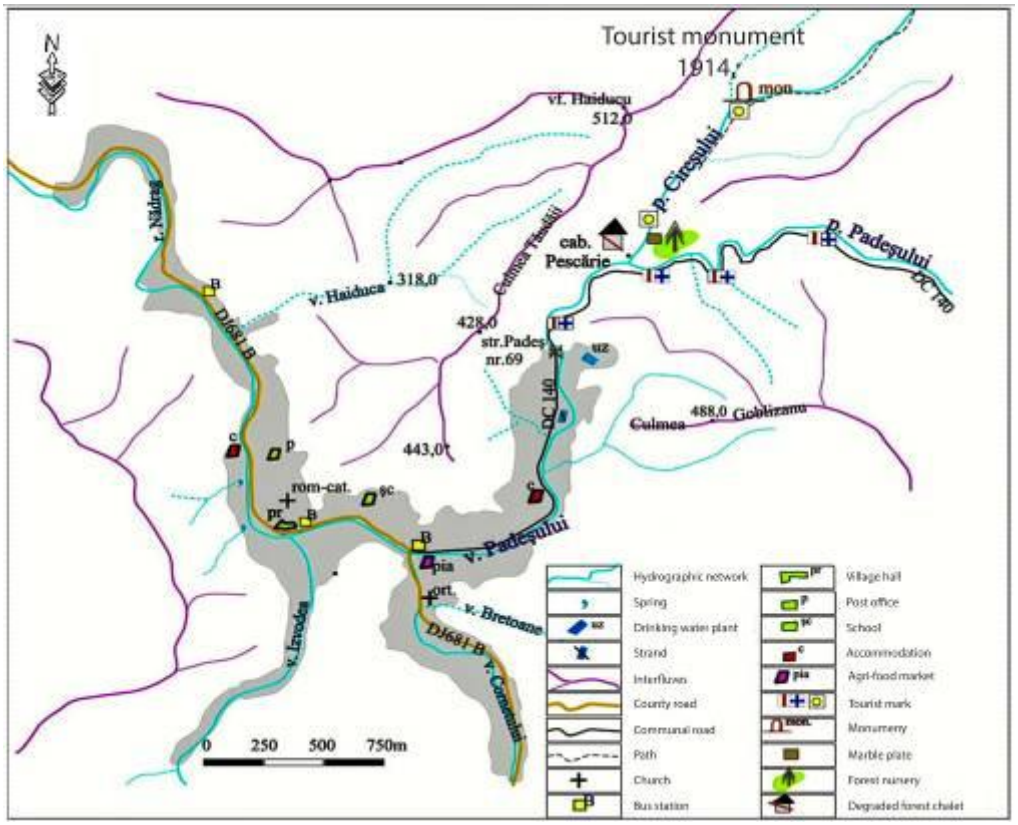

Figure 9. Drawing of Nădrag route to the Tourist Monument on Cireşului Creek

About the cottage Pescarie, the confluence of Pades valley with Ciresului Creek as a permanent tributary, take place. There, the paved village road ends and the way gets over the bridge (or through the water). The old road leads straight to the cottage.

By the cottage there is a trail that follows the Cireşului creek (figure 9). The trail is marked with the "yellow dot" up to the monument, but do not expect a circuit trail (it`s just a "back and forth" trail), in Nădrag tourist markings are placed at random by various amateurs (not necessarily locals).

Opposite the cottage "Pescărie" (figure 10) on a smooth spur, there is the Nădrag forest nursery (spruce and pine seeds are planted in a small greenhouse, then the seedlings are moved outdoors for a certain period of time after which they are taken on the field and planted on deforested hillsides) (figure 11). After the inlay of the trail along the narrow and forested Cireşului creek (mixture forest of hornbeam - Carpinus betulus and beech - Fagus silvatica) the slope gets a little bit steeper, but not enough to cause any problems and after completing the 1.5 km, at a level difference of 50 m (between the cottage "Pescărie" and the monument), one arrives at the old Tourist Monument.

Rusca Montană Tourism Monument

The second monument in Poiana Ruscăi Mountains, more widely known and publicized, is the Ruschiţa Tourism Monument (figure 12), built 22 years later than that of Nădrag, in 1937 under the Tourist Club Banat (TCB) Caransebeş, commissioned in 1937 (figure 14). The original location of the monument was within Ruschiţa village limits, in the mountains as well, at the edge of the forest in the section called "Seven Springs", on the trail leading from Ruschiţa to the top of Padeş Peak, through Tău Ursului lap. In 1984, due to the expansion of mining and water entrapment 'Seven Springs', the Tourism Monument was moved in the commune centre - the settlement of Rusca Montană, on the county road DJ 684 Voislova-Ruschiţa.

The Tourism Monument is represented by a marble column, 2.2 m high (H.G. Kräutner, 1984) which bears the following verses inscribed (belonging to Basil Magdaş forestry engineer, the promoter of this monument) (figure13):

"You, tourist who get to this woodside
Throw away your grief and spite
Try to grasp the nature`s ways
The divine spark: virtue of love."

It`s worth noting that this monument sets out on the frontispiece " The Tourism Monument" but the lyrics are clearly addressed to the "Tourist" and people generally perceive it as a monument of the tourist. Although the monument is made of eight blocks of white Ruschiţa marble, the main body has three massive blocks (like the one in Nădrag), the entire setup is placed on a pedestal in the form of a regular quadrangular prism with an 80 cm base and 40 cm height. On the website 2 and 3 there is the monographic file of the monument where the marbles blocks that make up the monument are described in detail; it is signed by Professor Viorel Florea, the correspondent of Nelu Balaş from Nădrag, both strongly concerned about preserving the history of places, and also by getting it known by as many people as they could. [1,2]

Rusca Montană commune is not exempted from heavy socio-economic problems, the consequences of ceasing complexes ore mining in this area and mine closures, but there is much involvement and tourism initiative from the local authorities. In this sense, every year since 1997, they organize the "Tourism Monument Day" and in the year 2013 a second marble monument dedicated to the village was celebrated.

[1] *http://www.banaterra.eu/romana/in_memoriam/monumente/monumentul%20turistului_poiana%20ruscai/index.htm*
[2] *http://scoalastefanvelovan.info/wp-content/uploads/2014/07/31.AGENDA-4-2006-31-august-MONUMENTUL-TURISMULUI.pdf.*

Figure 12. The Tourism Monument in Ruschiţa [3]

Figure 13. The lyrics incrusted in Ruschiţa marble [4]

Figure 14. Inauguration of the Tourism Monument in Ruschiţa, held on August 1st 1937 [5]

Ruschiţa is very popular nowadays due to the exploitation of generous marble deposit (figure 16) and the existence of bright white marble monument hasn`t been left forgotten or unmentioned (as happened at the Nădrag), so that both the quarry and the monument enhance the fame of Ruschiţa village and implicitly of Rusca Montană commune.

[3] *http://www.banaterra.eu/romana/toponimii/r/.../monumentul_turismului.doc.*
[4] *http://www.banaterra.eu/romana/toponimii/r/.../monumentul_turismului.doc.*
[5] *http://www.banaterra.eu/romana/toponimii/r/.../monumentul_turismului.doc.*

Figure 15. Now, two Ruschiţa marble monuments are guarding on the side of the road, at the entrance in Rusca Montană [6]

Figure 16. Ruschiţa marble quarry
(photo: Ribana Linc)

CONCLUSIONS

In a mountain massive with a tourism potential regarded as modest in the present times, people who inhabit Poiana Ruscăi Mountains felt the need at some point to draw attention to the beauty of nature - and not just from Poiana Ruscăi Mountains - and in the early twentieth century,

[6] *http://www.caon.ro/ziua-turismului-aniversata-la-monumentul-dedicat/1334206*

by the initiative of forestry engineers, they expressed it in a very plastic way by raising two monuments (one in Nădrag and the other in Ruschiţa), one dedicated to His Lordship the Tourist, perhaps sensing that without tourists there would be no sights, no travel, the other (younger) dedicated both to the Tourist and the Tourism.

The two monuments were strategically placed at that time on roads that connect to Padeş. On one of its sides were the iron ore mines, led then towards the steel industry in Nădrag, on the other side, the most beautiful Ruschiţa marble is exploited; it reaches the most diverse corners of the world and is highly appreciated. Then the vicissitudes of time have caused these trails to be abandoned, but the destiny of the two monuments was different. The one in Nădrag fell into oblivion prey to the weather whereas at Ruschiţa it was brought closer to civilization and taken care of, so that it`s been known for a long time and now is an important tourist attraction of the village Rusca Montană, and the Poiana Ruscăi mountains, being a kind of access key to the fabulous marble quarry at Ruschiţa, and to Padeş Peak (it receives a larger tourist movement to the peak from the Ruschiţa side than from Nadrag). Thus, it appears that Poiana Ruscăi Mountains is the only mountain complex in the country where human recreation by tourism is praised by the existence of two monuments dedicated to the tourist, although tourism activity present in these mountains is clearly modest.

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DATA CLASSIFICATION TECHNIQUES AND SYSTEM FOR PREDICTING DISCHARGES IN THE GAMBIA RIVER BASIN

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Abstract: Within the framework of water resources management, numerous research works and methods were led in world. In this trail, we noted a fast development of time series data mining (TSDM) which supplies a new method for water resources management. This article examines the trend of discharge during the high water period (from July till November) in the basin of Gambia measured at the Mako station for 1970-2013 period. Methodology consisted at first in calculation and in standardization of data by the method of z-score of some statistical parameters (mean, maximum, minimum, range and standard deviation). Obtained series were afterward submitted to classifications techniques such as k-means clustering and Agglomerative Hierarchical Clustering (AHC) of TSDM to cluster and discover the discharge patterns in terms of the autoregressive model. Based on these methods, a discharge forecast model has been developed. For the validation of the indicated model, and with respect to the maximum discharge, the coefficients of discharge growth and decay, respectively on the phase of rise and the phases of rise and descent waters, were calculated. This study presents basin discharge dynamics in high water period based on TSDM.

Key words: data mining; discharge; forecast model; hydrological process; clustering; techniques

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INTRODUCTION

In Senegal, the collection of climatological and hydrological data is managed respectively by the National Agency for Civil Aviation and Meteorology (ANACM) and the Directorate of Management and Planning of Water Resources (DGPRE). These data are very useful in research, analysis of historical trends and future forecasts. With the multiplication of databases, various techniques of data analysis and knowledge extraction are used worldwide (Mishra et al., 2014) and by researchers of various disciplines: hydrology, the environment, climatology, computer science, mathematics, etc. Today, the development of information technology has generated huge amounts of databases covering various fields of science and technology. Data mining is widely applied in the scientific research. Finding association rules, sequential patterns, classifying and grouping data are typical tasks involved in the data mining process. The various classification techniques all aim at distributing n individuals, characterized by p variables X1, X2, …, XP, into a certain number m of subgroups that are as homogeneous as possible, each group being well differentiated from the others (Larose, 2005). Two major classification techniques exist: partitioning and hierarchical classification.

Data mining refers to the extraction of knowledge from large amounts of data. The time series data mining (TSDM) methodology follows the delayed integration process to predict future occurrences of significant events. The tools of data mining boil down to neural networks and decision trees allowing the prediction of a qualitative variable (classification trees) or quantitative (regression tree) (Gupta and Chaturvedi, 2013). Nevertheless, the most innovative methods concern the search for association rules (Agrawal et al., 1993) which can lead to observations of the "composition of the consumer's shopping cart" type, and the study of frequent sequences allowing to understand customer behavior over time (Agrawal and Srikant, 1995). Two major types of methodologies preside over data mining techniques: the supervised mode which requires the definition of a dependent variable (thus some hypotheses) and the unsupervised mode where all the variables are considered on the same plane (detection of associations, classification, partition, etc.) (Crié, 2003). Hydrological databases are sets of various record values that diverge over time. Research based on the theory of data mining and hydrological techniques is needed to analyze hydrological, climatological and sedimentary databases for different types of study (Gupta and Chaturvedi, 2013).

The term "data mining" does not mean the generation of data or the data sets themselves, but only the practice of data analysis. Many of the methods used come from statistics: however, data mining is not a purely statistical process, but an interdisciplinary process that uses learning techniques from computer science and mathematics (especially learning unsupervised) and allied with artificial intelligence (Piatetsky-Shapiro and Frawley, 1991). These efficient methods are integrated into data mining software to enable the evaluation of large datasets (Agrawal and Srikant, 1995; Crié, 2003).

Classification has important role in science through usage of multidimensional statistic techniques. In biological sciences, such as botany, zoology, ecology, the term "taxonomy" is used to designate the art of classification. Also, the classification techniques are widely used in geosiences (geology, pedology, geography, study of the pollutions etc.). Over the past decade, a lot of effort has been conducted to extract knowledge from hidden historical data (Jayanthi, 2007). To this end, real-time hydrological forecasting is a major challenge for the scientific community (Mishra et al., 2014).

In the field of hydrological data mining, various techniques are used to extract knowledge from historical data (Mishra et al., 2013). Some of the topics of interest to this study are the discovery of models for the exploitation of hydrological data during the high water period in the Gambia River Basin.

Database extraction that combines the fields of time series analysis and data mining techniques (Aydin et al., 2009) therefore remains an essential technique for hydrological analyzes. The main objective of this study is to develop a data mining application using modern

information technology and to discover the hidden information or models behind the historical hydrological data during the high water period at Mako station in the Gambia River Basin. Data mining tools such as similarity search, k-means grouping and Agglomerative Hierarchical Clustering (AHC) model are used in this article.

STUDY AREA

For this work, the Gambia River was selected because of the high variability of water resources. Its basin, with an area of nearly 77,100 km², extends in latitude, from 11° 22' North (in the Fouta-Djalon) to 14° 40' North (in the Far-Eastern Ferlo) and, in longitude, from 11° 13' West (Fouta-Djalon) to 16° 42' West (Banjul, mouth) (Lamagat, 1989; Dione 1996; Sow 2007).

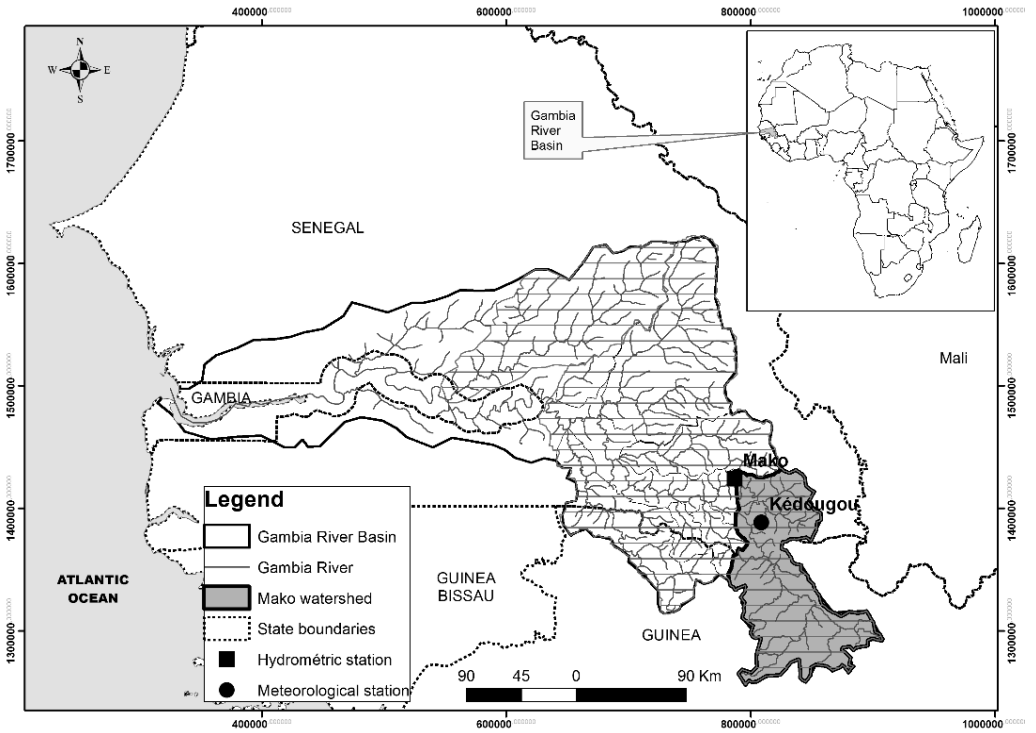


Figure 1. Gambia River Basin
(Source: CSE)

The length of the river at Mako Station is 328 km. The Mako Hydrometric Station is located on the main stream of the river. For this work, daily discharge data were taken over a period of 44 years (1970-2013). At the Kedougou meteorological station, the average maximum temperature is 30° C, the minimum temperature is 25° C and the precipitation is 1000 mm (1970-2013) (figure 1).

DATA AND METHODS

Select a data set

For this work, the daily data of discharge of the Mako station and climatological data (precipitation and temperature) of Kédougou were collected at the DGPRE. The daily data, in accordance with the requirements of the methods used, were converted into monthly means. On the monthly values of discharge (Q), a series 44 years is chosen (1970-2013) and the tests were carried out on a period of high water (July-November).

Statistical analysis, data standardization

The five statistical parameters (Q_{mean}, $Q_{maximum}$, $Q_{minimum}$, Q_{range} and $Q_{deviation}$) were calculated on each month with the discharge data. In order to have an efficient analysis of the data on the series and the period considered, the calculated parameters were normalized using the z-score technique through the following formula:

$$z = \frac{(x_i - x_m)}{\sigma}$$

With x_i which is the value of the month, x_m the mean of the series and σ the standard deviation of the series.

Standardization was necessary to prevent the results of the study from being affected by large variations in the data.

Data segmentation

For data segmentation, analysis of the basin hydrograph and Monthly Discharge Ratio (MDR, as the ratio of the monthly discharge to the annualy discharge) (Table 1) at the Mako station over the period 1970-2013 divides it into 3 segments: low water (May-July), high water (August-October) and low water (November-April). For this study, although the months of July and November are months of lowwater (MDR <1), they are used in the period (so-called high water) on which the tests are applied. This choice can be explained by the importance of their past discharges.

Table 1. Monthy Q values and MRD at Mako station (1970-2013)
(Data source: DGPRE)

	M	June	July	A	S	O	N	D	J	F	M	A	Year
Q (m^3/s)	0.23	7.42	78.8	310	432	201	64.1	23.6	11.3	5.30	2.09	0.37	95
MDR	0.002	0.08	0.83	3.26	4.54	2.12	0.67	0.25	0.12	0.06	0.02	0.00	1
	Low waters			High waters			Low waters						

The discharge of watercourses changes gradually with the changes in rainfall. The different climates in the basin thus cause different discharge processes for a better study of the discharge processes, the study of the climatic framework is fundamental as indicated in the works of Faye (2018) and Faye and Mendy (2018). This studies highlight the great climatic variability in the Gambia Basin with the presence of two periods: a wet period marked by pluviometric abundance during the 1950s and 1960s and a dry period marked by drought in the 1970s and 1980s (Faye, 2018; Faye and Mendy, 2018). On the other hand, during the 2000s, it was noted in the Gambia River Basin that an increase in rainfall predicted the improvement of rainfall patterns in the basin compared with the drought period of previous decades. However the persistence and sustainability of the increase are still to be proven, knowing that the long enough climatological scale is thirty years (Faye et al., 2017). In this article, the period of high water is chosen and the statistical data obtained here have been subjected to classification tests.

Apply K-means clustering and find out number of clusters

The k-means classification is a very efficient iterative method for finding spherical groups in small and medium sized databases. Its application requires several times the calculations in order to retain only the most optimal solution for the chosen criterion. For the first iteration we choose a starting point which consists in associating the center of the k classes with k objects (taken randomly or not). The distance between the objects and the k centers is then calculated and the objects are assigned to the centers of which they are nearest. Then we redefine the centers from the objects that have been assigned to the different classes. Then the objects are reassigned according to their distance to the new centers, until the convergence is reached (Gupta and Chaturvedi, 2013).

Apply DTW and find out similarities and dissimilarities

The search for similarity in time series analysis is one of the fastest and most demanding areas of development in data mining. Unlike normal database queries, which find the data corresponding to the given query exactly, a similarity search finds data sequences that differ only slightly from the given query sequence. It can be classified into two categories (Gupta and Chaturvedi, 2013):

The "all correspondence" category: In this type of time series data matching must be of equal length.

The category "subsequent correspondence": In this category, a sequence of requests X and a longer sequence Y were taken. The goal is to identify the sequence in Y, starting with Yi, which has the best matches of X, and to account for its shift within Y. The main difficulty is to define a measure of similarity (Rakthanmanon et al., 2012). For the analysis of similarity of time series data, Euclidean distance is generally used as a measure of similarity. Given two sequences, X = (x_1, x_2,…., xn) and Y = (y_1, y_2,…., y_n) with n = m, the Euclidean distance is defined as follows (Mishra et al., 2014):

$$D(X,Y) = \sqrt{\sum_{i=1}^{n}(x_i - y_i)^2}$$

The DTW (Dynamic Time Warping) Algorithm: The DTW is an algorithm for measuring the optimal similarity between two data sequences. The series data vary not only over time amplitudes, but also with the progression of time that hydrological processes can reveal different velocities in response to different environmental conditions. A nonlinear alignment produces a similar measure, allowing similar shapes to match even if they are out of phase in the time axis (Ding et al., 2008). The sequences are nonlinearly "deformed" in the time dimension to determine a measure of their similarity independent of certain nonlinear variations in the time dimension. To find the best alignment between X and Y time sequences one needs to find the way through the grid.

Apply Agglomerative Hierarchical Clustering (AHC) algorithms and find out dendograms

To identify the discharge model from the corresponding data series, each hydrological period obtained after k-means clustering was taken, and then analysis of a discharge model in each of the periods was made. The analysis involved 5-year hierarchical classification techniques with observance of mean discharge data for selected months over the hydrological period. AHC is a subdivision of hierarchical clustering and a bottom-up approach, which proceeds by a series of fusions of the N objects into groups. If it is given a set of N items to be clustered and an N*N distance (or similarity) matrix then the basic process of agglomerative hierarchical clustering applied in this study is done iteratively following these four steps (Gupta and Chaturvedi, 2013) (figure 2): 1. Start with N clusters each containing a single entity, and an N × N symmetric matrix of distances (or similarities) Let dij = distance between item i and item j. 2. Search the distance matrix for the nearest pair clusters (i.e., the two clusters that are separated by the smallest distance). Denote the distance between these most similar clusters U and V by d_{UV}. 3. Merge clusters U and V into new clusters labeled T. Update the entries in the distance matrix by (a). Deleting the rows and columns corresponding to clusters U and V, and (b). Adding a row and column giving the distances between the new cluster T and all the remaining clusters. 4. Repeat steps (2) and (3) a total of N-1times.

In our analysis, the discharge pattern (time series data of discharge for the months in the hydrological period) of a year (among 44 years) is clustered into several clusters. But the year which formed the cluster center formed the pattern with its discharge data for the months in the period. All other members (years) in the cluster attained membership of the cluster because there was similarity to the year representing the center so they can be said to follow the pattern.

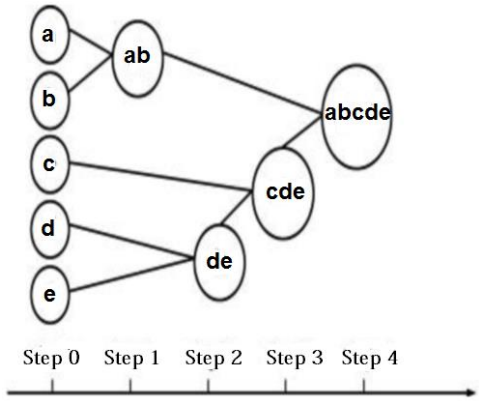


Figure 2. Cluster tree obtained by AHC
(Source: Gupta and Chaturvedi, 2013)

Now, the center (the year) in the cluster is obtained, plotting of the discharge data of that year corresponding to daily discharge in the months, along the x-axis would give the pattern.

Like the k-means classification, the techniques of AHC and the criterion Wards are applied over the period of high water (July to November) on the 44 years selected (1970-2013) for the analysis of the models. AHC is particularly useful for finding hidden models in multidimensional data. Since this is an unsupervised learning pattern, the number of classes can be large or small at times.

Calculate moving average in monthly discharge standardized data

A sliding mean, also known as moving average, is a type of finite impulse response filter used to analyze a set of data points by creating a series of means of the different subsets of the complete set of data. A moving average is commonly used with time series data to smooth out short-term fluctuations and highlight long-term trends or cycles. The threshold between the short term and the long term depends on the application, and the parameters of the moving average will be set accordingly. The simple moving average formula is given below (Gupta and Chaturvedi, 2013):

$$S_t = \frac{1}{k}\sum_{n=0}^{k-1} x_{t-n} = \frac{x_t + x_{t-1} + x_{t-2} + \cdots + x_{t-k+1}}{k} = x_{t-1} + \frac{x_t + x_{t-k}}{k}$$

With which is the simple moving average, k the observations, t the data point with respect to time and n the number of data points.

Calculate coefficient of growth and decay with respect to peak discharge

On either side of the month of the maximum discharge (September with 432 m^3/s) (figure 3), it seems necessary to calculate the growth coefficient and the decrease of the discharge to validate the stream discharge model before and after the peak. In hydrology, the coefficient of discharge growth or decay (k) is usually expressed in the following exponential decay (Mishra et al., 2014):

$$\frac{Q}{Q_0} = e^{-kt}; \qquad so \qquad \log\left(\frac{Q}{Q_0}\right) = \log(e^{-kt})$$

Applying the natural logarithm of the two sides and deducing k while knowing that t is here equal to 1 (one month), we obtain:

$$k = -l\,\mathrm{og}\left(\frac{Q}{Q_0}\right) \quad = \quad logQ_0 - logQ$$

Where k is the coefficient of discharge growth or decay, Q the monthly mean discharge, Q_0 the discharge in the previous month.

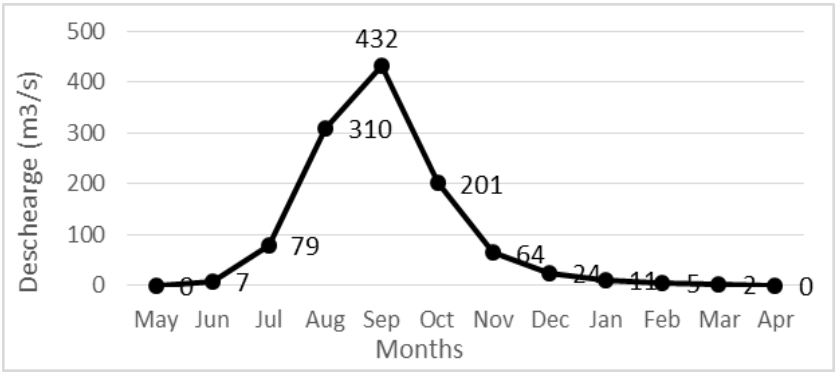


Figure 3. Evolution of the mean monthly discharges at Mako (1970-2013)
(Data source: DGPRE)

To base the methodology raised, the XLSTAT tool 2014 software version, which contains the implementation of various classification algorithms (such as K-means, AHC, etc., and other data mining techniques), is used. For this work, the daily discharge data for the period from July to November over 44 years (from 1970 to 2013) are used. XLSTAT is used to classify and find classes.

RESULTS AND DISCUSSION

The k-means method

After the division of the hydrological period into three segments and the choice of the period of high water (from July to November) for this study, the statistical parameters (mean, maximum, minimum, range and standard deviation) obtained and standardized over the period 1970 -2013 were subject to a grouping of k-means. Thus, a total of 220 (5 months in each of the 44 years) cases (months) based on the 5 parameters from the data of the chosen period was used and subject to this grouping. Table 2 indicates a classification of the different months according to obtained (four) classes.

Table 2. Assignment Classes by Object After Application of K-means from 1970 to 2013
(Data source: DGPRE)

Observation	Class	Distance to centroid	Observation	Class	Distance to centroid	Observation	Class	Distance to centroid	Observation	Class	Distance to centroid
Jul-70	1	4.97	Jul-81	1	1.67	Jul-92	4	0.87	Jul-03	1	2.14
Aug-70	2	1.89	Aug-81	4	1.44	Aug-92	4	0.65	Aug-03	1	1.62
Sep-70	1	1.82	Sep-81	3	0.71	Sep-92	1	1.31	Sep-03	1	1.3
Oct-70	3	0.32	Oct-81	3	0.28	Oct-92	3	0.54	Oct-03	4	0.34
Nov-70	4	0.51	Nov-81	4	0.68	Nov-92	4	0.41	Nov-03	4	1.41
Jul-71	4	0.83	Jul-82	4	1.17	Jul-93	4	0.86	Jul-04	1	2.59
Aug-71	4	0.73	Aug-82	3	0.77	Aug-93	3	1.15	Aug-04	4	0.95
Sep-71	3	0.89	Sep-82	3	0.38	Sep-93	3	1.26	Sep-04	4	1.61
Oct-71	3	0.28	Oct-82	3	0.51	Oct-93	3	0.47	Oct-04	4	0.95
Nov-71	4	0.71	Nov-82	4	0.55	Nov-93	4	0.78	Nov-04	4	0.38
Jul-72	4	1.21	Jul-83	3	1.02	Jul-94	1	0.93	Jul-05	2	2.44
Aug-72	4	0.84	Aug-83	3	1.05	Aug-94	4	0.91	Aug-05	1	1.8
Sep-72	3	0.96	Sep-83	3	1.9	Sep-94	4	1.75	Sep-05	4	0.89
Oct-72	3	0.34	Oct-83	3	0.38	Oct-94	4	0.94	Oct-05	4	0.29
Nov-72	4	0.57	Nov-83	4	0.91	Nov-94	4	1.45	Nov-05	4	0.32
Jul-73	1	3.2	Jul-84	2	1.34	Jul-95	1	1.8	Jul-06	3	0.6
Aug-73	2	1.83	Aug-84	3	1.16	Aug-95	2	0.76	Aug-06	3	0.86
Sep-73	4	1.54	Sep-84	3	2.8	Sep-95	4	1.42	Sep-06	4	0.99
Oct-73	3	0.28	Oct-84	3	1.03	Oct-95	4	0.75	Oct-06	4	0.65
Nov-73	4	0.72	Nov-84	4	0.97	Nov-95	4	0.57	Nov-06	4	0.48

Jul-74	1	1.32	Jul-85	1	0.96	Jul-96	4	0.87	Jul-07	4	0.46
Aug-74	2	0.46	Aug-85	4	1.47	Aug-96	4	0.65	Aug-07	3	1.78
Sep-74	3	1.69	Sep-85	4	0.52	Sep-96	1	1.31	Sep-07	3	0.85
Oct-74	4	0.58	Oct-85	4	0.98	Oct-96	3	0.54	Oct-07	3	0.72
Nov-74	4	0.37	Nov-85	4	0.67	Nov-96	4	0.41	Nov-07	4	0.66
Jul-75	1	0.82	Jul-86	3	0.44	Jul-97	2	0.79	Jul-08	2	1.16
Aug-75	4	0.96	Aug-86	3	1.11	Aug-97	2	0.37	Aug-08	2	1.48
Sep-75	1	1.28	Sep-86	3	0.74	Sep-97	4	0.4	Sep-08	1	1.66
Oct-75	4	0.26	Oct-86	3	0.58	Oct-97	4	0.34	Oct-08	4	1.27
Nov-75	4	0.4	Nov-86	4	0.61	Nov-97	4	0.29	Nov-08	2	1.57
Jul-76	1	2.42	Jul-87	3	0.63	Jul-98	4	0.88	Jul-09	4	2.13
Aug-76	4	0.11	Aug-87	3	1.33	Aug-98	4	1.81	Aug-09	4	1.59
Sep-76	3	0.75	Sep-87	3	0.52	Sep-98	1	1.5	Sep-09	2	1.03
Oct-76	4	0.91	Oct-87	4	0.49	Oct-98	4	0.53	Oct-09	4	0.9
Nov-76	4	1.07	Nov-87	4	0.42	Nov-98	4	0.21	Nov-09	4	0.77
Jul-77	3	0.54	Jul-88	4	1.01	Jul-99	4	0.73	Jul-10	3	0.32
Aug-77	3	1.49	Aug-88	4	1.78	Aug-99	4	0.62	Aug-10	4	0.68
Sep-77	3	1.22	Sep-88	4	0.94	Sep-99	4	0.53	Sep-10	2	2.14
Oct-77	3	0.72	Oct-88	3	0.22	Oct-99	4	1.35	Oct-10	2	1.69
Nov-77	4	0.63	Nov-88	4	0.71	Nov-99	4	0.59	Nov-10	1	3.37
Jul-78	3	0.81	Jul-89	3	1.03	Jul-00	4	0.68	Jul-11	1	0.74
Aug-78	4	0.76	Aug-89	4	1.53	Aug-00	4	1.22	Aug-11	4	1.67
Sep-78	1	1.9	Sep-89	4	0.6	Sep-00	3	0.66	Sep-11	4	1.29
Oct-78	4	0.79	Oct-89	3	0.63	Oct-00	4	1.21	Oct-11	1	1.47
Nov-78	4	0.41	Nov-89	4	0.52	Nov-00	4	0.16	Nov-11	4	0.5
Jul-79	4	0.67	Jul-90	4	0.29	Jul-01	4	0.45	Jul-12	4	2.01
Aug-79	3	0.62	Aug-90	3	1.95	Aug-01	4	0.35	Aug-12	4	1.53
Sep-79	3	1.27	Sep-90	3	0.85	Sep-01	4	1.03	Sep-12	4	0.55
Oct-79	4	0.73	Oct-90	3	0.73	Oct-01	4	0.89	Oct-12	1	0.79
Nov-79	4	0.39	Nov-90	4	0.66	Nov-01	4	0.55	Nov-12	4	0.53
Jul-80	1	0.93	Jul-91	1	1.13	Jul-02	3	0.59	Jul-13	4	1.24
Aug-80	2	0.53	Aug-91	4	1.29	Aug-02	3	0.29	Aug-13	1	1.35
Sep-80	4	1.03	Sep-91	3	0.64	Sep-02	3	1.78	Sep-13	4	0.54
Oct-80	3	0.15	Oct-91	3	0.33	Oct-02	4	0.49	Oct-13	3	0.93
Nov-80	4	0.81	Nov-91	4	0.57	Nov-02	4	0.7	Nov-13	4	0.96

Table 3. Centroids of classes after the application of K-means from 1970 to 2013
(Data source: DGPRE)

Class	Mean	Max	Min	Range	Standard deviation	Sum of weights	Within-class variance	Minimum distance to centroid	Mean distance to centroid	Maximum distance to centroid
1	0,70	1,57	-0,10	1,73	1,72	28	3.91	0.74	1.72	4.97
2	1,31	0,46	1,92	-0,02	0,13	15	2.21	0.37	1.30	2.44
3	-1,05	-1,41	-0,73	-1,31	-1,25	59	0.97	0.15	0.84	2.80
4	-0,32	-0,34	-0,36	0,26	-0,31	118	0.86	0.11	0.82	2.13

From a typology (segmentation), this method of data analysis made it possible to obtain a simple schematic representation of the complex starting data table. This resulted in a partition of n individuals (months) into classes, defined by the observation of p variables (mean, maximum, minimum, range and deviation). Table 3 gives the class centers of gravity (these are the coordinates of the centroids of the classes for the different parameters) and the results by class (Sum of weights, Within-class variance, Minimum distance to centroid, Mean distance to centroid, Maximum distance to centroid).

Depending on the distribution of cases in the classes, the annual discharge process could be obtained as separate classes. For this work where only the high water period is used, the k-means algorithm also offers one of the graphical representations of the processed data. Thus figure 4 shows evolution curves of a set of statistical parameters analyzed by the k-means algorithm (mean, maximum, minimum, range and standard deviation).

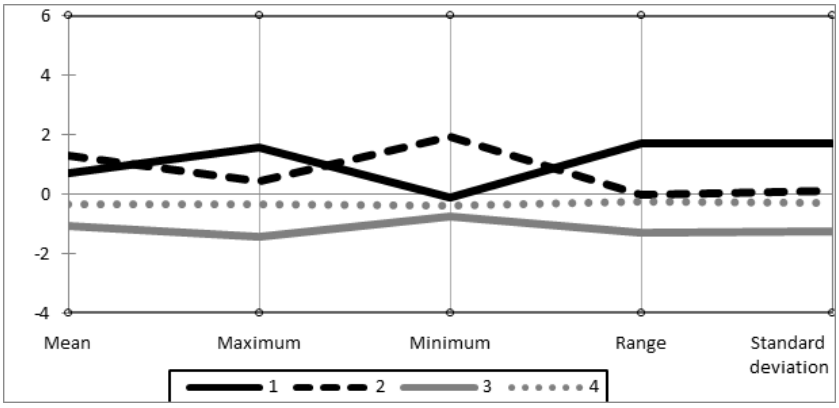


Figure 4. Graphical representation of the classes obtained by the application of K-means from 1970 to 2013 (Data source: DGPRE)

Agglomerative Hierarchical Clustering (AHC)

Like the k-means classification, the techniques of AHC are applied over the period of high water (July to November) on the 44 years selected (1970-2013) for the analysis of the models. The main role of AHC is to identify classes or groups of discharge series that are similar. By applying the AHC algorithm on the data set, four different classes were obtained (table 4).

Table 4. Classes of assignment by object after application of the AHC from 1970 to 2013 (Data source: DGPRE)

Observation	Class	Observation	Class	Observation	Class	Observation	Class	Observation	Class	Observation	Class
Jul-70	1	Sep-77	3	Nov-84	3	Aug-92	3	Oct-99	3	Jul-07	3
Aug-70	2	Oct-77	4	Jul-85	1	Sep-92	3	Nov-99	3	Aug-07	4
Sep-70	3	Nov-77	3	Aug-85	3	Oct-92	4	Jul-00	3	Sep-07	4
Oct-70	4	Jul-78	4	Sep-85	3	Nov-92	3	Aug-00	4	Oct-07	4
Nov-70	3	Aug-78	3	Oct-85	3	Jul-93	3	Sep-00	4	Nov-07	3
Jul-71	3	Sep-78	3	Nov-85	3	Aug-93	3	Oct-00	3	Jul-08	2
Aug-71	3	Oct-78	3	Jul-86	4	Sep-93	4	Nov-00	3	Aug-08	3
Sep-71	3	Nov-78	3	Aug-86	4	Oct-93	4	Jul-01	3	Sep-08	3
Oct-71	4	Jul-79	3	Sep-86	4	Nov-93	3	Aug-01	3	Oct-08	3
Nov-71	3	Aug-79	4	Oct-86	4	Jul-94	1	Sep-01	4	Nov-08	3
Jul-72	3	Sep-79	4	Nov-86	3	Aug-94	3	Oct-01	3	Jul-09	3
Aug-72	3	Oct-79	3	Jul-87	4	Sep-94	3	Nov-01	3	Aug-09	3
Sep-72	4	Nov-79	3	Aug-87	4	Oct-94	3	Jul-02	4	Sep-09	2
Oct-72	4	Jul-80	1	Sep-87	4	Nov-94	3	Aug-02	4	Oct-09	3
Nov-72	3	Aug-80	2	Oct-87	3	Jul-95	3	Sep-02	4	Nov-09	3
Jul-73	1	Sep-80	3	Nov-87	3	Aug-95	2	Oct-02	3	Jul-10	4
Aug-73	2	Oct-80	4	Jul-88	3	Sep-95	3	Nov-02	3	Aug-10	3
Sep-73	3	Nov-80	3	Aug-88	4	Oct-95	3	Jul-03	2	Sep-10	2
Oct-73	4	Jul-81	3	Sep-88	3	Nov-95	3	Aug-03	2	Oct-10	2
Nov-73	3	Aug-81	3	Oct-88	4	Jul-96	3	Sep-03	2	Nov-10	2
Jul-74	1	Sep-81	4	Nov-88	3	Aug-96	3	Oct-03	3	Jul-11	1
Aug-74	2	Oct-81	4	Jul-89	4	Sep-96	3	Nov-03	3	Aug-11	3
Sep-74	4	Nov-81	3	Aug-89	3	Oct-96	4	Jul-04	1	Sep-11	3
Oct-74	3	Jul-82	3	Sep-89	3	Nov-96	3	Aug-04	4	Oct-11	3

Nov-74	3	Aug-82	4	Oct-89	4	Jul-97	2	Sep-04	3	Nov-11	3
Jul-75	1	Sep-82	4	Nov-89	3	Aug-97	2	Oct-04	3	Jul-12	3
Aug-75	3	Oct-82	4	Jul-90	3	Sep-97	3	Nov-04	3	Aug-12	3
Sep-75	2	Nov-82	3	Aug-90	4	Oct-97	3	Jul-05	2	Sep-12	3
Oct-75	3	Jul-83	4	Sep-90	4	Nov-97	3	Aug-05	3	Oct-12	1
Nov-75	3	Aug-83	4	Oct-90	4	Jul-98	3	Sep-05	3	Nov-12	3
Jul-76	1	Sep-83	4	Nov-90	3	Aug-98	3	Oct-05	3	Jul-13	3
Aug-76	3	Oct-83	4	Jul-91	1	Sep-98	3	Nov-05	3	Aug-13	1
Sep-76	4	Nov-83	3	Aug-91	3	Oct-98	3	Jul-06	4	Sep-13	3
Oct-76	3	Jul-84	3	Sep-91	4	Nov-98	3	Aug-06	4	Oct-13	4
Nov-76	3	Aug-84	4	Oct-91	4	Jul-99	3	Sep-06	3	Nov-13	3
Jul-77	4	Sep-84	4	Nov-91	3	Aug-99	3	Oct-06	3		
Aug-77	4	Oct-84	3	Jul-92	3	Sep-99	3	Nov-06	3		

For class analysis of the AHC, the Sum of weights, the Within-class variance, the Minimum distance to centroid, the Mean distance to centroid, the Maximum distance to centroid are calculated (table 4) and represented in graph form (figure 5).

Table 5. Centroids of classes after the application of AHC from 1970 to 2013
(Data source: DGPRE)

Class	Mean	Max	Min	Range	Standard deviation	Sum of weights	Within-class variance	Minimum distance to centroid	Mean distance to centroid	Maximum distance to centroid
1	0,70	1,57	-0,10	1,73	1,72	13	3,37	0,50	1,56	3,96
2	1,31	0,46	1,92	-0,02	0,13	17	3,49	0,49	1,61	3,57
3	-1,05	-1,41	-0,73	-1,31	-1,25	131	1,27	0,22	0,99	2,58
4	-0,32	-0,34	-0,36	-0,26	-0,31	59	1,09	0,15	0,87	2,84

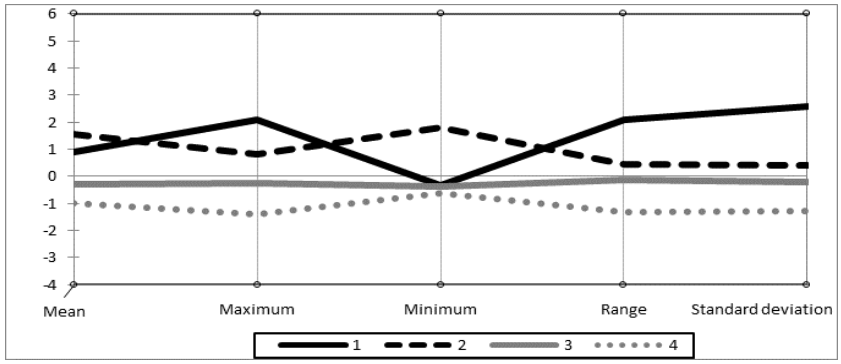


Figure 5. Graphical representation of the classes obtained by application of the AHC from 1970 to 2013
(Data source: DGPRE)

Similarity analysis, model detection and growth and decay coefficient with respect to peak discharge

The observation of similarities is also made on data from the high water period from 1970 to 2013. This technique is applied to indicate similar discharges between the months and years of the series. This is because the time series of discharge rates vary not only in terms of expression amplitudes, but also in terms of temporal progression, because the stream flows at different rates in time depending on different natural conditions or at different locations in the

basin at different times (Mishra et al., 2014). For this study, the distance between objects and k centers indicated by the k-means classification technique is used as the similarity matrix for the high-water period (table 6). These distances between the central objects represent the Euclidean distances between the central objects of the classes for the different descriptors. The similarity matrix made it possible to compare the monthly discharges of the 44 years of the series. For example, the distances between the central objects indicate strong similarities between the months of August 1976 and October 1980.

Table 6. Distances between the central objects for the period of high water according to the k-means from 1970 to 2013
(Data source: DGPRE)

	July-2011	**Aug-97**	**Oct-80**	**Aug-76**
July-2011	0	3.96	5.34	3.47
Aug-97	3.96	0	4.51	3.24
Oct-80	5.34	4.51	0	1.92
Aug-76	3.47	3.24	1.92	0

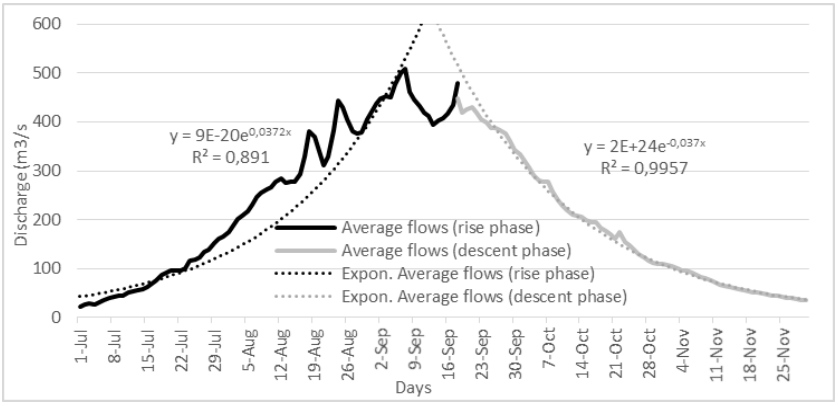
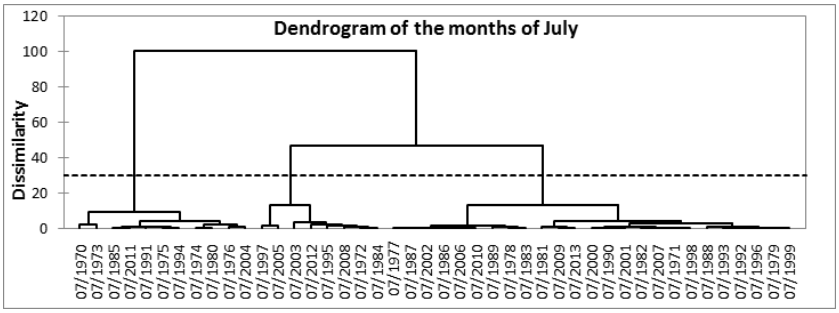


Figure 6. Growth models and the decrease in mean discharge from 1970 to 2013
(Data source: DGPRE)

The detection of the models is carried out from the means of the daily discharges of the period of high water of 1970 to 2013. The evolution of the mean daily discharges of the series makes it possible to indicate the model (figure 6), and taking into account the similarities, we can say all the years of the series follow it. In Figure 6, the model has been detected for both the rising up phase of the discharge and the falling down phase from the peak.



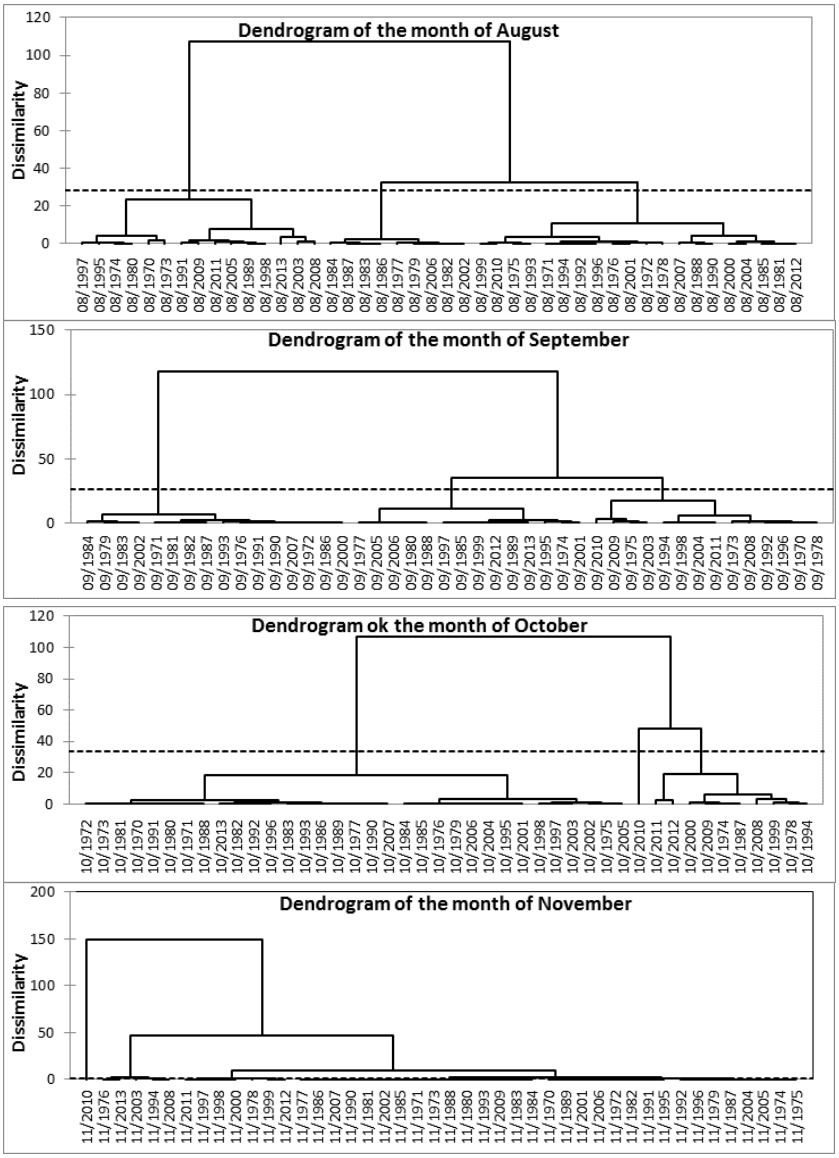


Figure 7. Dendrograms obtained after application of AHC from 1970 to 2013 (Data source: DGPRE)

The analysis of the ascending hierarchical classification is based on a tree diagram: the dendrogram. The latter, obtained by the application of the AHC, is a bottom-up hierarchical classification approach, which takes place by series of mergers of different years (1970-2013) for every month (July to November) into classes (figure 7). In these tree diagrams, the height of each U-shaped line indicates the distance between the different years for every month. For the growth and decay coefficient with respect to the peak of the discharge, the results are shown in table 7. If for the rise phase, the coefficients k are all positive, which indicates a growth of the discharges, on the other hand on the descent phase, they are negative, which is synonymous with a decrease in discharge rates. The rate of growth of discharges (k) is higher between the months of June and July due to the low discharge. On the other hand between July-August and August-September, k is certainly positive (which indicates an increase of the discharge) but weaker

because of the importance of the discharge. On the descent phase, the decay rate (k) noted between September and October and between October and November indicates the gradual decline in the discharge in the basin. This decrease in discharge is more significant between October and November, in relation to the end of the rainy season in the basin. The coefficients k thus indicate the real image of the rise and fall of the discharges respectively on each side of the peak of the annual discharge. The absolute values of k indicate whether the discharges are low or high. Positive values mean the discharge is increasing and negative that it is decreasing.

Validation of results based on the causal effect

In this work, we try to analyze the nature of the variation of the discharge of the basin during the period of high water through graphs (figure 8) representing the data of past discharges. Hydrological processes have shown a cause-and-effect relationship with rain events, since it is the climatic setting that determines the modalities of river discharge. Thus, the evolution of rainfall and temperatures over the high-water period, on a monthly scale, is shown in Figure 8, which shows a fairly similar model consistent with the past-discharge model, which shows the importance of precipitated water slides and their contribution to the water slides that have passed. The evolution of the rain is accompanied by a second-order polynomial regression, whose equation is displayed at the top.This regression better reflects the monthly evolution of the rain in the basin at the Kédougou station) from 1970 to 2013.

Table 7. Mean values of coefficients (k) of growth (July, August, and September) and decay (September, October, and November) compared to discharge peak (1970-2013) per five years
(Data source: DGPRE)

Periods	Rise phase			Descent phase	
	July	**August**	**September**	**October**	**November**
1970-71 / 1974-75	0.87	0.64	-0.03	-0.47	-0.51
1975-76 / 1979-80	0.91	0.49	0.27	-0.27	-0.52
1980-81 / 1984-85	1.00	0.49	0.06	-0.42	-0.53
1985-86 / 1989-90	1.19	0.63	0.17	-0.40	-0.57
1990-91 / 1994-95	1.39	0.50	0.15	-0.36	-0.46
1995-96 / 1999-00	0.78	0.73	0.14	-0.36	-0.56
2000-01 / 2004-05	1.37	0.52	0.15	-0.37	-0.47
2005-06 / 2009-10	1.02	0.64	0.15	-0.26	-0.55
2010-11 / 2013-14	0.98	0.69	0.29	-0.16	-0.30

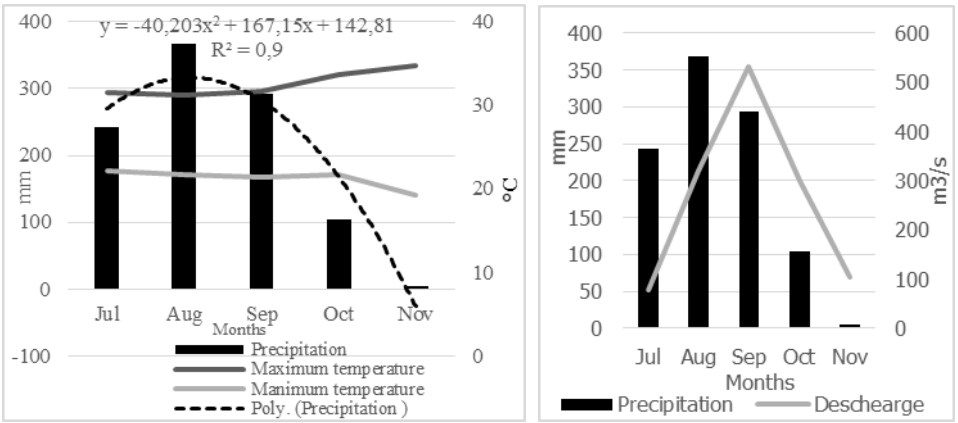


Figure 8. Mean monthly maximum and minimum temperatures and precipitation (a) and precipitation and discharge (b) at Mako (1970-2013)
(Data source: DGPRE)

Rainfall distribution could be observed throughout the high water period. In this paper, the following observations strongly validate the obtained models: 1) the evolution of past discharges is similar to hydrographs on each year during the high water period; 2) the evolution of discharge tends to increase during periods of high rainfall; 3) The rainfall - discharge pattern shows more similarities, despite the lag of one month between the peak of the rain and that of the discharge. However, the methods applied have disadvantages (Creusier and Biétry, 2014). For the k-means method, the disadvantage is that it does not make it possible to discover what can be a coherent number of classes, nor to visualize the proximity between classes or objects (Rakotomalala, undated; Lelu, 2008; Creusier and Biétry, 2014). For the AHC, the main disadvantage is that it requires the calculation of distances between individuals taken two by two. This is very quickly prohibitive as soon as the file size exceeds 1,000 individuals (Lerman, 2009; Creusier and Biétry, 2014). If several methods are proposed for the general problem of classification, each having its strengths and weaknesses, the ascending hierarchical methods (AHC technique) are used more than the K-means methods in case of small data as it was the case for our study period (44 years period) because the complexity is very high. On the other hand, if run time problems arise, then the K-means methods are used.

For the application of the k-means method and AHC techniques, it has been found that the AHC technique is more accurate and its main advantage over other classification methods lies in this representation in the form of a tree that evidence additional information: the increase of the dispersion in a group produced by an aggregation. The user can then have an idea of the adequate number of classes by choosing the partition corresponding to the highest jump in the increase of the dispersion within the classes (Lerman, 2009; Creusier and Biétry, 2014). This AHC technique makes it possible to highlight a "natural" grouping of a set of individuals described by characteristics (the variables). It offers a series of nested partitions represented in the form of trees called dendrograms. The algorithm proceeds by successive aggregations, starting from the most fragmentary partition, an individual is equal to a class, until the trivial partition, the grouping of all the individuals in one and only one class. In addition, the k-means and AHC methods are therefore complementary.

In many fields of the social sciences, we are led to form groups homogeneous within them and which differ sufficiently from each other. This is the purpose of the classification methods of which the k-means and AHC methods method is part (Creusier and Biétry, 2014). These techniques are currently one of the most used and most effective in data analysis. In fact, they make it possible to partition a finite population of elements into a number K (integer) of homogeneous classes. It is useful to note that their algorithms are very efficient in terms of execution time, but they suffer from the problem of dependence of the results on the choices made during the initialization. We can expand our work, trying to compare our results with other versions of K-means and AHC methods, working on other unsupervised classification algorithms, and even the supervised ones (Masmoudi, 2017).

CONCLUSION

The discovered models are more similar to discharge models. The comparison of hydrographs and precipitation during the same period was made and it is proved that the discharge models were more similar in this period. Our future studies could focus on other periods (low water periods), or a much longer data series (eg over 44 years) for a more complete study of the hydrological behavior of the Gambia Basin at the Mako hydrometric station in particular and even on other stations of the basin.

As we pointed out in the introduction, there are several classification methods. For better results and to overcome the disadvantages of using a single method, recent studies encourage the use of so-called mixed methods. A mixed method is a method that groups together several classification algorithms. In this study, the classification algorithm includes two different analyzes: the k-means method and AHC techniques. If several methods are proposed for the

general problem of classification, each having its strengths and weaknesses, the ascending hierarchical methods (AHC technique) are used more than the K-means methods in case of small data as it was the case for our study period (44 years period) because the complexity is very high. On the other hand, if run time problems arise, then the K-means methods are used.

The k-means method has allowed us not only to reduce the size of the data, but also to define a subspace in which our data will be easily represented. The AHC techniques made it possible to carry out the Hierarchical Ascendant classification proper. These techniques are currently one of the most used and most effective in data analysis. In fact, they make it possible to partition a finite population of elements into a number K (integer) of homogeneous classes.

From the hydrologic point of view, this classification can also be used as a tool to reduce the number of hydrological parameters to be used in the framework of design projects. We can identify the number of months in the high water period with the hydrological parameters close to the median of each class or, using the prediction model obtained by the discriminant analysis. It is however essential to evaluate the error related to the use of a set of parameters because the months on the period of high water belonging to a class do not have all the same hydrological parameters. Therefore, the uncertainty in the modeled temperature profile should be estimated when using the median as the metric that represents the class by varying the medians. It will also be possible to use the hydrological parameters of the other months over the high-water period, always with the same calibration, to evaluate the error by comparing the simulated temperature profiles.

We can expand our work, trying to compare our results with other versions of K-means and AHC methods, working on other unsupervised classification algorithms, and even the supervised ones.

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TOURISM DEVELOPMENT MODEL OF THE MINING AREAS FROM THE WESTERN PART OF PETROŞANI DEPRESSION. CASE STUDY: LUPENI TOWN

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Abstract: The present paper aims to suggest some ways of functional and aesthetic rehabilitation of lands affected by mining activity within the western part of Petroşani Depression and especially of Lupeni town. The study wants to show the great potential of these anthropic landforms which can be used for tourism development the area. The landscape is an important resource, being a remarkable natural and cultural heritage that is appreciated for its beauty and aesthetics, but also its contribution to the identity of a region. Beyond how the landscape sheds light on ways of looking at the world, it also confronts us with the issues of nature and how we relate to it. On the other hand, the urban and industrial development forces us to talk about urban landscape, industrial landscape, or technological landscape. The mining landscape from the periphery of Lupeni town can be a subject of touristic development, taking into account the economic problems of the area and the environmental issues made by the the mining activities through time.

Key words: landscape, mining, tourism, sterile dump, Petrosani Depression, Lupeni

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INTRODUCTION

Petroşani Depression is considered a low compartment into the Carpathians, being limited to the North by mountain ranges: Retezat and Şureanu, South and Southeast of Vâlcanului and Parang Mountains. NNE-SSW has guidance about having a length of about 45 km and a width ranging from East to West between 9 and 12 km. It includes six settlements with their localities: Petrila (Lonea, Jieţ, Cimpa), Petroşani (Dâlja, Livezeni), Aninoasa (Iscroni), Vulcan (Dealul Babii, Paroşeni), Lupeni, Uricani (Valea de Brazi, Câmpu lui Neag), with a population in 2011 of 120 734 inhabitants, the largest town beeing Petroşani (37 160 inhabitants). The area of study is a micro-region from Transylvanian Carpathians, traversed by the West Jiu River (51.4 km) and East

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Jiu (28 km), whose confluence at the Petroşani (Livezeni) leads to the formation of Jiu River, which forms one of the most beautiful gorges in the country, now designated as a nature park.

The geographical position, hydrological and morphological elements, the landscape, as the entire tourism potential that it possesses a highly recommended as a tourist destination waiting to be fully discovered (Ardeiu, 2004; Nimară, 2011; Nimară et al., 2017; Tofan et al., 2017).

Lupeni town is located in Hunedoara county, at 20 km SW from Petroșani, at 700 m, close to Vâlcan mountains. It has an area of 7 773 ha and 23 390 inhabitants, being considered the third largest town from Petroșani Depression. It borders on the west with Uricani town, on the south with the Gorj county, and in the north, partly with Vulcan town and Baru parish, it is located parallel to the West Jiu river, being guarded by two rows of mountains, which connect the Retezat Mountains with the Parâng Mountains, giving the town an elongated shape (Nimară et al., 2017).

The Lupeni town meets the characteristics of a well-defined geological basin, hydrographic basin and general morphological and geographical depression. According to the shape and position it holds in the relief complex, the municipality of Lupeni, is part of that huge longitudinal corridor, which divides the Southern Carpathians. This is a depression corridor with strong regional accents, which is due not only to the late modeling of the Southern Carpathians, but also to their structure and the tectonic definition of this unit in different geological stages. Considering the settlement of the localities in the depression, differentiation of the climatic elements will be observed in comparison with other regions. The depression character favors the accumulation and stagnation of the cold air, which causes frequent temperature inversions even between the relief units with low altitudes. In summer, the heaters are stronger due to the reduced circulation, so that the daily and annual thermal amplitudes will be different from other regions. The average annual values of air temperature calculated over a period of 60 years have values of 6.8°C. The monthly average values are between -4.5°C in January and 16.7°C in July, so there is an annual amplitude of 21.2°C. The values of the quite low annual amplitude are due to the frequency of the sea air masses, which in this part is still higher than in other regions, having an open corridor to the west.

The average dates of the first frost appear around October 10, and the frost days disappear after May 1st. The average duration of the annual frost-free interval (days with a minimum temperature above 0°C) is 150-159 days. The absolute humidity of the air, respectively the water vapor, has an annual average value of 6.9, the lowest values being recorded in winter in January, and the highest values, in summer in July. The variation in altitude of the annual average temperature, the amount of solar radiation and the duration of the vegetation season is also reflected in the specificity of the soil processes.

MATERIAL AND METHODS

The elaboration of the present paper involved the study of the spatial elements and a relational analysis between the anthropic landforms made by the mining activity and the economical and social needs of this part of Petrosani Depression. The data used to carry out this study was obtained from the specific literature and from the field. Also, to achive a better result, I have used landscape design software, named Lands Design 4.6. The results consist in the creation of a 3D model of the future land, being restored according to the social and economic needs of the people living in this area. The proposed model can be an example for mining land restoration which can be used as an alternative, or an additional model to the development of the tourism industry in the Petrosani Depression.

VISUAL ANALYZE OF THE MINING LANDSCAPE FROM THE PERIPHERY OF LUPENI TOWN

As with any mining operation, the management of the sterile generated by the Lupeni Mining Exploitation has raised some environmental problems. The sterile resulting from the primary extraction and processing of the coal are stored in sterile dumps located in a hilly area, north of Lupeni town, about 2 km from it (Lupu, 1967).

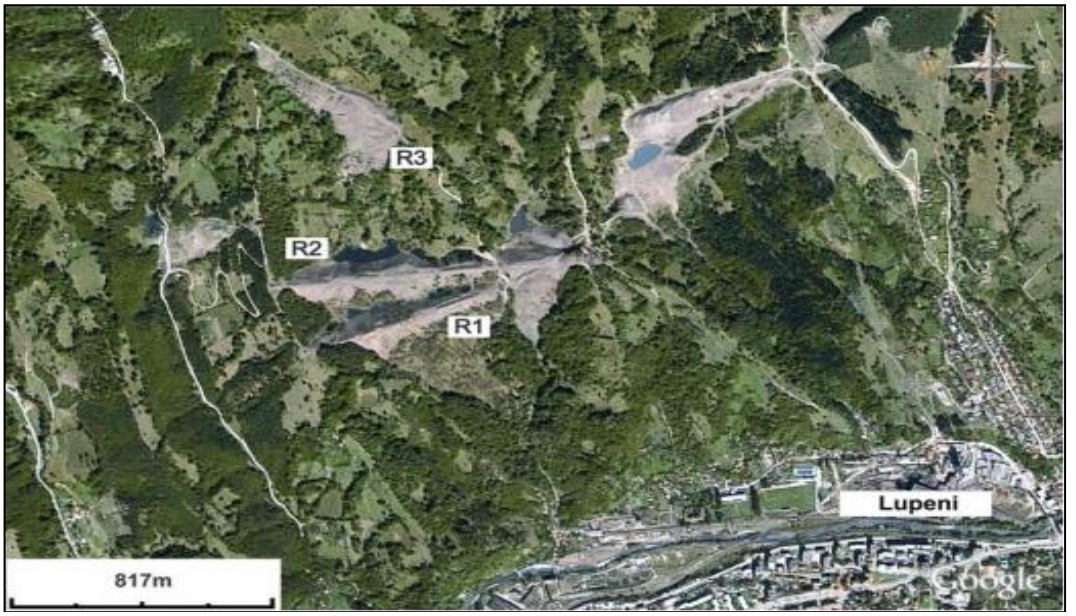

Figure 1. Sterile dumps from the periphery of Lupeni town Hunedoara County
(Source: Google Earth, 2019)

In choosing the site, the aim was to affect a small area of land with a low economic importance. The sterile was transported using the funicular, and the storage has been carried out on three branches (denoted by R1, R2, R3) built in a single bench. Of these, only the southern branch (R3) is currently active, the other two being closed (Mitrea, 2000).

The sizes of the branches vary between 900 m - the R1 branch and 1 200 m - the R3 branch, and their heights between 40 and 70 m. The total surface occupied by the sterile dump is about 34 ha. As a result of the configuration of the deposit, it has exhibited several phenomena of instability over time although at present it is stabilized. The sterile dumps have an obvious impact on the landscape (being visible both from the city and from the slope opposite to the one on which they are located), the morphology and hydrology (the lifting of the dump bodies allowed the formation of lakes by blocking water courses or by accumulating rainwater).

Figure 2. Lakes near the sterile dumps

Also, the sterile has also changed the state of the ecosystems thus appearing new ecosystems which are poorly developed. They have a high potential for supporting biotic communities and for tourist development (Nimară and Tofan, 2015).

PROPOSED MODEL FOR DEVELOPMENT OF THE MINING LANDSCAPE

Because mining and related activities have left such an important imprint on the landscape of the Lupeni town, it is necessary to find specific solutions for aesthetic and/or functional reintegration. In order for these solutions to be efficient, suitable and capable of being implemented in this type of territory, it is necessary to take into account it climatic, hydrographic, hydrological and geological characteristics, but also economic and social characteristics. Therefore, in the best case, in order to fade the anthropic imprint it is necessary to design the landscape in such a way that these surfaces are masked with respect to the surroundings until the end of the mining activity, in the case of branch 3. Afforest of sterile dumps involves two procedures, to reclaim and adapt. This model of restoration of an anthropic area is applied in most cases, especially when it does not present a potential for economic recovery, due to the low implementation costs.

As a proposal for the correction of the problems that have been installed on these areas and for a more natural aesthetics, considering their neighborhoods, it is recommended to afforest, in order to create a public park, respectively a holiday village. In addition to the functional benefits that such operation brings (providing a proper microclimate, protection against erosion, regulating the thermal and water regime), there is also the pleasant landscape it creates, in contrast to the current situation. The only disadvantage of this method is the long time required for the development of optimum vegetation and the formation of a vegetative soil substrate.

First of all, for an efficient and sustainable refurbishment it is necessary to perform leveling, consolidation and bank-sloping of the dumps to stop any possibility of producing landslides. With the installation of the soil layer, the sowing and development of grassy vegetation will gradually reduce the degree of infiltration and avoid the formation of acid waters. Later, different species of trees and shrubs can be planted to increase the degree of stability of the anthropic structure. For a normal vegetation development, it is preferred to provide temporary protection by enclosing the sterile dumps. Green represents the living element and must be considered the protection element that has a significant control role in the image of the suburban territory (McHarg, 1995). The status of a living element also results in its dynamic feature in terms of surface area. Even from the appearance of the urban space, the landscape architecture of the town was largely subject to the natural landscape, as also a similar structure can be found in the contemporary town, altered, however, by the social and economic aspects necessary for the coexistence of the human habitat (Hall et al., 2005, Baciu, 2014).

It appears as an asymmetrical element that occurs in the case of the development of forests in the vicinity of the town. The green is built by parks, as the main elements that must have the following location, in the case of the ideal arrangement of the green spaces:

- the largest park must be located in the center of the citadel;
- smaller parks must be connected to the central one and to the urban habitat structures.

The anthropic degraded land, like the one on which the sterile dumps were deposited in the suburban area of the Lupeni town, can be transformed into useful, safe and functional land through a minimum of "greening", with certain special measures, meant to ensure conditions for vegetation. Why minimum, because, in general, nature has begun to regain the surfaces occupied by humans activities, by the appearance of spontaneous species, but also of perennial species.

The land recovery should not be related only to the need of improving the lands degraded by the mining activity in order to return to the initial capacity but more to ensure the subsequent use in various other socially and economically functional purposes, constituting as a necessity of modern society (Crețu et al., 2013; Herman et al., 2016; Moore, 1998; Reid, 2007) (figure 4).

Figure 3. Natural vegetation on the sterile dump

Figure 4. The proposed model

There so, the proposed model to use these anthropic landforms as a base of tourism development where it can be build a touristic village and park (figure 5). The plantations, the grass lawns, the floral decorations, which make up the created anthropic landscape (Buia et al., 2017), want to be integrated into the natural structure of which they are part. All of these are located in a natural landscape rich in vegetation and harmoniously organized, so that the forms of recreation created do not generate functional conflicts (for example, agitation and noise for those who choose for calm and passive relaxation), contributing to the restoration of energy and psychic tonus, necessary for daily activities (Bold and Nimară, 2016).

On the old sterile dumps were installed birch trees, and in the erosion zones a natural process of consolidation began with "pioneer" species such as the coltsfoot and the white sea buckthorn. On the slopes predominates the birch tree (the age of the most vigorous specimens being about 9-10 years), also sporadic specimens of hazelnut or ash (Cooke and Doomkamp, 1990; Darmer and Dietrich, 2001). On the upper platform of the dump body, which was leveled at the time when it was active, the degree of cover with grassy vegetation is about 50-60%, sporadic specimens of birch, dog rose and even trembling poplar are encountered.

Figure 5. 3D model of the new landscape

In accordance with the type of vegetation encountered on the ground, the plant species I propose to continue the vegetation process is in tune with the bottom lines of the landscape that nature has chosen (waist, structure, texture, color), but also based on soil analyzes. These are: birch, sea buckthorn, pine, willow and different species of grassy vegetation. The ornamental species chosen belong to the category of trees with columnar, tabular and plethora form: bush, juniper, thyme, willow and various species of roses. The chosen size is part of category III, namely, trees with the maximum height between 7 and 15 m. The afforest of the sterile dumps and the land in their immediate vicinity will be carried out on an area of 7.2 ha, being based on the consideration of the height of tree growth, so as to create a uniformity of structure, form and linearity of the landscape. At the base it is recommended to plant the species of black pine, being followed by red pine and wild pine, at distances of 3 m, 2 m and 1.5 m between trees. The plastic qualities of small shrubs, as individual pieces, can be used especially in the details of the composition, noticeable nearby: on the banks of the lakes, in the rockery, next to rocks and at the bottom of the stairs. The fine foliage, combined with the more aerated branch, gives to the semi-transparency silhouettes, effects of light and shadow games (birch, larch, red sea buckthorn); the dense foliage, accompanied by a thick branching, determines a strong contouring of the silhouettes, a complete shielding of the vision and accentuated shadows (linden tree, thyme, box).

In this way is obtained a landscape expressiveness, depending on the growth forms. Viewed from a certain distance, the selected elements can be reflected on the grass carpet, on the gloss of the water, on the sky, on the background of other plantations or on built surfaces (facades of buildings). At the same time, the absence of leaves in the cold season makes the tree architecture more prominent, creating remarkable landscape effects.

CONCLUSIONS

The “post-industrial land” represents the area used in the past for a certain industrial activity of production, transport or storage which is currently unused or decommissioned and which in the past has played an important role in the economic development of the region.

The mining activity has strongly affected the environmental components of the analyzed area. Despite this, biological, soil and water analyzes showed good quality of terrestrial and aquatic biotic environments. This is due in particular to the relatively high capacity of the sterile dumps to support life forms. In the absence of the ecological rehabilitation measures, the capacity

of the sterile dumps to reintegrate into the natural circuit can be possible by its location in a hilly area, surrounded by well developed forests, but also by the physical, chemical and biological characteristics it has. The proposed solutions for the landscape reintegration of the suburban area of the Lupeni town have on one hand an aesthetic value, trying to rebuild the degraded landscape after the deposition of the sterile material resulting from the coal exploitation and on the other hand, to offer a note of social and economic functionality to an anthropic degraded land, which didn't have an increased economic value before. At the same time, through the arrangement of this perimeter for tourism and recreational purposes, forest fruits and handmade items can be sell in the touristic village, in specially arranged stands.

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THE HUMAN CAPITAL IN THE UNDERPRIVILEGED MOUNTAIN AREAS OF BIHOR COUNTY

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Abstract: The current study captures the quantitative and qualitative features of the human capital in Underprivileged Mountain Areas from Bihor county, from the perspective of the human component that plays a major role in the preservation and development of these areas, both from natural and human point of view. The planned study focuses on the quantitative features (the number of population and the exerted pressure) and the qualitative ones (age and gender group structures, employed population and its distribution on branches of activities, the level of education) analysed for the year 2011 (data provided by the latest census). The analysis of these parameters highlights the fact that, from the human capital perspective, The Underprivileged Mountain Area corresponds to the demographic state of the county and the risk of depopulation is not poignant at the moment.

Key words: human capital, Underprivileged Mountain Area, population number, depopulation

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INTRODUCTION

At present, the mountain areas constitute a landmark in the political, socio-economic and scientific dialogues which take place at global level, precisely due to their natural, climatic, economic, social, cultural characteristics and their vulnerability, as well.

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Furthermore, the importance and role of mountain areas have been highlighted both in scientific studies (the well-known French academic journal *Revue de Géographie Alpine* is a symbol of these) and also in official documents (reports, laws, recommandations). Last but not least, there are national and international associations established to preserve and protect these vulnerable natural environments (Borsdorf and Braun, 2009). Agenda 2, in the second section addresses the 13th chapter to the management of vulnerable ecosystems, namely the mountain areas. In 2003, in Quito, Ecuador was launched the Charter for World Mountain People approved by 40 countries. The objectives pursued in both documents mentioned are the research of all existent components and resources, the aim being the preservation of the mountain environment regarded as a mandatory condition for the survival of the global ecosystem (Rey, 2007). Moreover, the most entitled international body and the main funder of programmes dedicated to the improvement of the environmental state Global Environment Facility (GEF) perceives the moutain areas as ”one of the high-priority ecosystems for the preservation of biodiversity”(Borsdorf and Braun, 2009, p.104).

Last but not least, the protection, preservation and development of mountain areas, especially the underprivileged ones, constitute a major coordinate of the European Union development policy. The concerns for protecting the mountain areas have old roots throughout the Europen countries, the legislation regarding the moutain issued by France and Italy being of reference (Borsdorf and Braun, 2009). 1994 represents a key moment when in Chamonix, France was organised the first European Conference of mountain regions, led by the European Council when the European Charter of Mountain Regions was promoted.

The European policy of development lays great emphasis on mountain areas, a large number of documents and reports targeting them. A revealing example in this respect is the 1257/1999 Regulation of CE regarding the aid for rural development.

The ESPON 2004 report concerning mountain regions in Europe makes a relevant radiography of mountain areas. Chapter 5, Demographic tendencies in mountain regions, is dedicated to human resources (ec.europa.eu/regional..../montagne/mount1_fr.p).

In this European context, favourable for the preservation and development of mountain areas, shall be recorded the protection and preservation measures of underprivileged mountain areas in Romania. The Strategic Concept for Territorial Development Romania, 2030, drawn based on Europe Strategy 2020, mentions „the planning management policy has to pay special and appropriate attention to the preservation and development of mountain regions” p. 11.

Under Law 351/2001 concerning the National Territorial Plannig (Locality network section) and Order 355 from 10 May 2007, respecting the requirements of the CE 1257/ 1999 Regulation, in Romania there were delimited the territorial units declared Underprivileged Mountain Areas, applying the European criteria. Another important step was the amendment of Mountain Law 347/2004 by the Emergency Act (OU 21 from 27.02. 2008) to harmonise the European and Romanian support and protection policy.

Under the above mentioned law, in 2007, in Romania were identified and declared as such, 657 territorial units (municipalities, towns and communes) located in 27 counties. The Underprivileged Mountain Areas in Romania cover a surface of 71 340 km², (22,93% of the country’s surface) inhabited by 2 400 000 people, representing 11% of the total population.

In Bihor county, the Underprivileged Mountain Areas cover a surface of 1884,2 km² that comprises 19 territorial units (3 towns, 16 communes), grouping a number of 56 297 inhabitants, approximately 10% of the county’s population in 2011 (figure 1). One of the fundamental component of the mountain system is represented by the population who lives in this restrictive and vulnerable area and who faces several hardships such as the exodus of population, impoverishment and not least the loss of cultural identity.

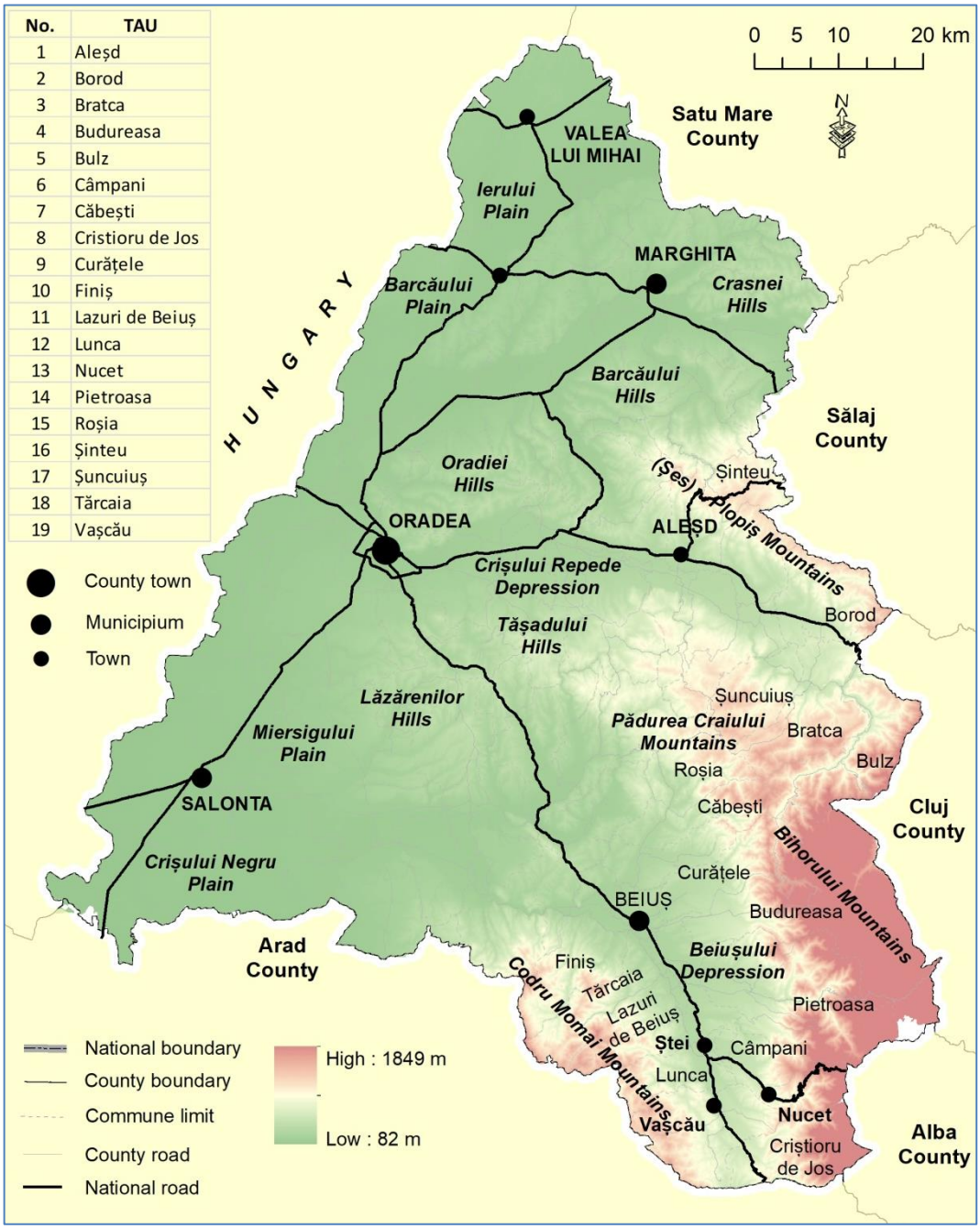

Figure 1. Underprivileged Mountain Areas in Bihor county

At present, the research carried out wants to demonstrate the fact that one of the main pillars, perhaps primal, which has to sustain the preservation/development policies in undeprivileged mountain areas, is the human capital who, by the qualitative and quantitative features and way of management could be the savior or the destroyer of the mountain.

The approach of these territories from the human capital perspective, that generates production and consumption as well in this space, is a sensitive one because, unlike other areas, underprivileged mountain areas suffer from natural drawbacks which cannot be overcome, and also structural disadvantages (distance from the decision-making centers, deficient technical and building stock infrastructure), all of them having a direct impact on human behaviour, the guarantor for the development of any area.

METHODOLOGY

The mountain areas have always generated the reserachers' interest from varied fields, especially geographers'. In this respect, we mention in direct connection with the aimed area, the studies about the demographic risks in Apuseni Mountains (Surd et al., 2007; Filimon and Filimon, 2011; Mureșan, 2014), the mining brownfields with emphasis on tourism development (Morar, 2012, 2013), population, settlements, tourist activities (Filimon et al., 2009, 2011; Filimon, 2014; Herman and Benchis, 2017; Herman et al., 2019; Lung and Gligor, 2018; Lung, 2019; Novac, 2006; Stașac et al., 2016). The main objective is the analysis and highlight of the human capital in the Underprivileged Mountain Areas associated to Bihor county. To reach this goal, some relevant and widely used parameters have been selected (Lecaillon, 1992; Dumont, 2012; The ESPON report, 2011; The European Commission, 2011; SIESTA, 2014). Therefore, to capture the quantitative and qualitative characteristics of the human capital, we used the following parameters: number of population, gender structure, age-group structure, employed population and distribution on sectors of activity. Another indicator was the population level of education, which indicates the quality and the perspectives of human capital. These parameters were analysed using data supplied by the population census from 2011.

RESULTS AND DISCUSSIONS

The number of population is the direct result of its numerical evolution throughout time. Naturally, over time, the total number of population in the Underprivileged Mountain Areas registered fluctuations determined by a number of factors: demographic, social, political, historical and natural ones. The number of population offers not only a real image regarding the existent demographic potential, but also the pressure exerted on the natural environment, by the density values.

The total population registered at the last census, in 2011, in the studied area is 56 297 inhabitants, representing 9,9% of the county's total population. At territorial level, there are major differences between communes and towns, recording a maximum of over 10 000 inhabitants in Aleșd town and a minimum of 1021 inhabitants in Șinteu commune (table 1). In fact, within the area, with the exception of Aleșd, only five territorial units register a population of over 3000 inhabitants, an average value for the communes in the country. The other communes, including Nucet and Vașcău towns, register lower values of the population.

Table 1. Total population and population density in the Underprivileged Mountain Area in Bihor county

No.	TAU	Population number	Surface (km^2)	Population density (inhab./km^2)
1	Aleșd	10 006	72,45	138,9
2	Borod	3843	105,62	36,4
3	Bratca	5158	136,48	37,8
4	Budureasa	2581	346,46	7,4
5	Bulz	2104	99,39	21,2
6	Câmpani	2427	44,49	54,6
7	Căbești	1848	71,18	26,0
8	Criștioru de Jos	1354	101,71	13,3
9	Curățele	2509	91,10	27,5
10	Finiș	3680	104,70	35,1

11	Lazuri de Beiuș	1518	58,92	28,5
12	Lunca	2887	69,61	41,5
13	Nucet	2165	41,11	52,7
14	Pietroasa	3209	205,35	15,6
15	Roșia	2384	72,52	32,9
16	Șinteu	1021	49,33	20,7
17	Șuncuiuș	3259	72,04	45,2
18	Tărcaia	1969	76,70	25,7
19	Vașcău	2315	65,04	36,5
20	**Total area**	**56297**	**1884,2**	**29,9**

Regarding the exerted pressure, looking at the population density values we can state that the degree of anthropization is low, the average density value being that of 29,9 inhab./km², which is under the national average for the mountain areas, 33,6 inhab./km². The values registered in the administrative units range between a maximum of 138,9 inhab./km² in Aleșd and 7,4 inhab./km² in Budureasa. This should not come as a surprise since Budureasa commune has the biggest surface and Aleșd is among the units with relatively small territorial surface.

Gender structure

It is highly important because it offers information regarding the balance between genders. Moreover, it represents the foundation for the demographic policies and contributes crucially to the development of certain activity sectors (Filimon, 2014). From the total population in the territorial units from the area, the female population represents 50,7% (28 586 people), and the male population is 49,3%, 27 711 people, respectively. It can be noticed that, from this point of view, there is a certain balance between the genders, this situation is explainable by the mountainous character of the area and the economic activities typical for men. The male over-mortality occurs over the age of 60. Obviously, at the level of administrative units there are differences generated by specific situations (figure 2). Thereby, the male popualtion holds higher values compared to the female population in some communes: Roșia 51,7%, Căbești 50,3%, and in Șuncuiuș and Șinteu communes there is a balance between the genders. These exceptions are explained by the specific of the existent economic activities, mining and wood exploitation, which influence the population gender structure. The lowest levels of the male population are registerd in Vașcău, 47,9%, generated by the industrial restructuring and Tărcaia, 48%, due to agricultural activities (vegetable growing).

Age-group structure

The function of an area is closely connected to the population age-group structure, which determines the workforce potential, educational activities, the organization of certain services, especially those of health, and not least the consumption.

The distribution of population on the three major age groups, 0-14 years old, 15-59 years old and 60 and over 60 years old, highlights some characteristics (figure 3). The largest proportion is registered by the adult population 15-59 years old, 33 422 people, 59,2% from the total population respectively. This age-group generated the workforce and the biologic potential of the studied area. With higher values than the average are the towns Aleșd and Nucet and several communes: Bulz, Câmpani, Finiș, Pietroasa, Șinteu, Tărcaia, all with a percentage of over 60%. These higher values are due to the fact that the first are towns and in the communes the economic activities carried out (agricultural, agropastoral and tourism) contribute to the population stability.

The young population is the most diminished numerically, 9199 people, representing 15,3% of the total population. This low value is the result of the process of demographic aging, social-ecomonic changes and a new approach to the idea of family with direct influence on this age group. Even if most of the territorial units are within the average for this area, there are some

with values over the average. This is the case of Finiș (21,2%), Borod, Bratca, Budureasa, Roșia, Șuncuiuș communes and the town Aleșd with over 18%. The explanation for these higher values lies in the recovery of the economic sector in these areas, reinforced by the presence of some communities with a different demographic behaviour from that registered at general level (pentecostals in Finiș, gypsies/Romani people in Șuncuiuș, Pietroasa).

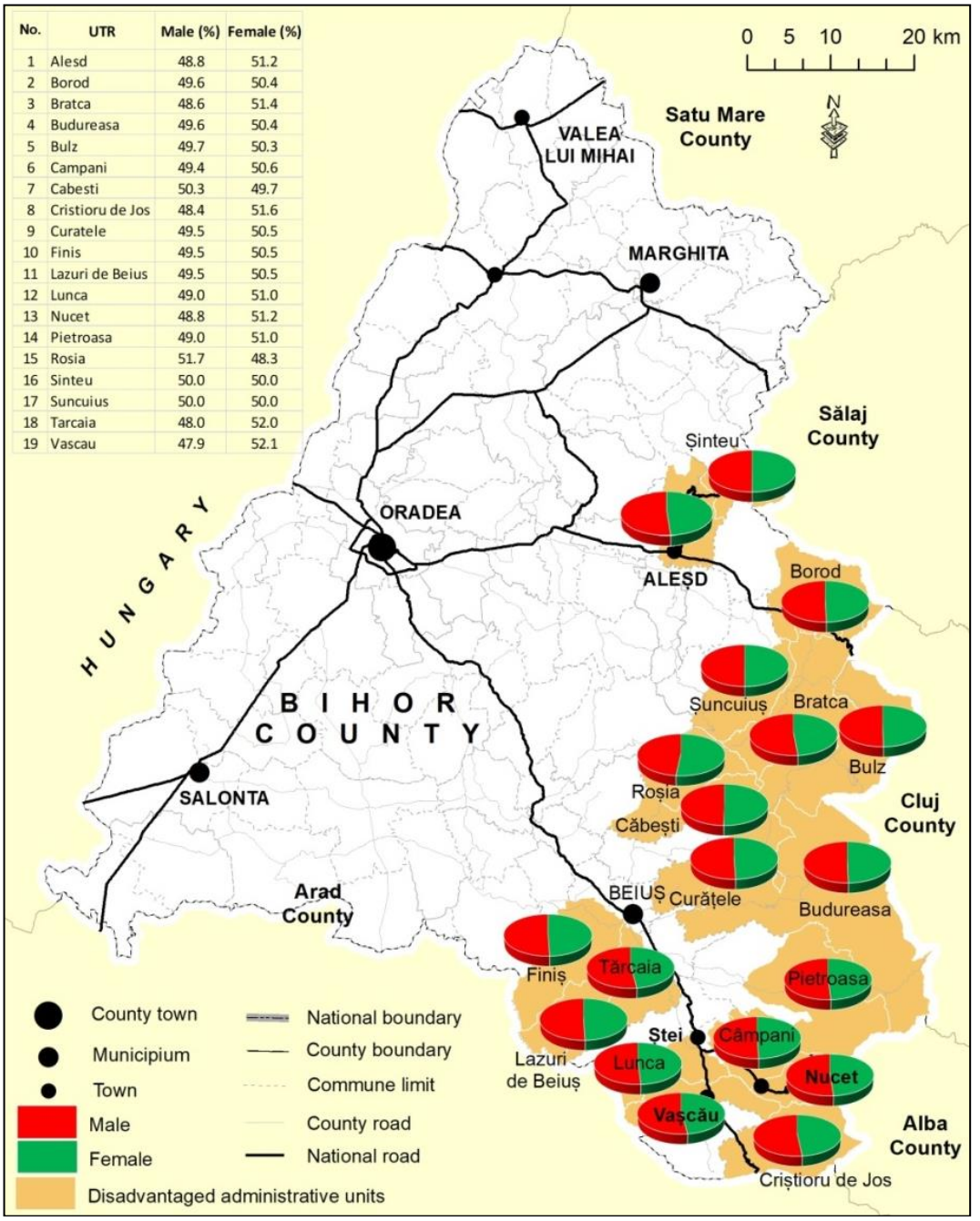

Figure 2. Population gender structure

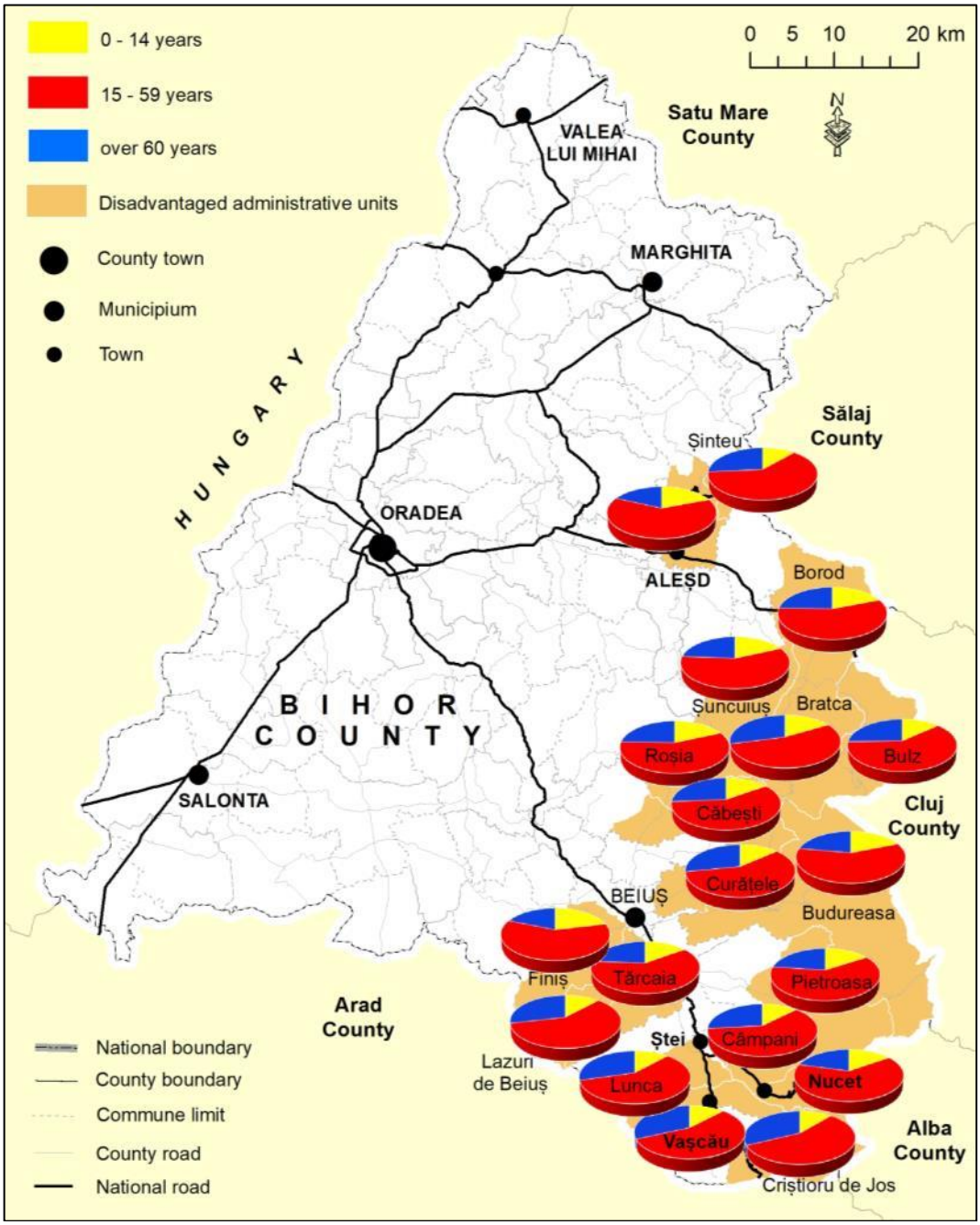

Figure 3. Structure on major age-groups

The elderly population numbers 13 674 people, meaning 25,5% of the total population, a value much higher than the one registered at county level (21,1%). It has to be noted that, in this group, the highest proportion is registerd by the female population, with a percentage of 60%.

The low level of economic and social attractiveness of the mountain space for the young population and the outward migration influence the values registered by the elderly and the

process of demographic aging. The territorial constraints amplified by the socio-economic situation is very-well exemplified by the two extremes: the town Aleșd with a low percentage of old population, 18,1%, and the commune Crișțioru de Jos and the town Vașcău with highest percentage of old population, over 31%, respectively.

Employed population

Being dependent on th socio-economic climate and level of development, the emplyed population reflects the concentration way and development status attained by the production forces, becoming a reference in the functional definition of the communities. At the level of the entire Underprivileged Mountain Area, the employed population represents 23 453 people, 41,7% from the entire active population, value which corresponds to the value recorded at county level (41,8%). From all the territorial administrative units, in 8 of them the registered values are above the average, with a maximum of 70,9% in Șinteu commune (figure 4).

The lowest value is registered in Finiș commune, where the employed population represents a percentage of 28,2%. It is worth mentioning the fact that in all the three towns located in the area the proportion of employed population is under the overall average, a fact that emphasises the different mentality in the rural space towards work compared to the population in the urban areas under the new socio-economic conditions.

Closely linked to the employed population is the population structure on sectors of activity. This parameter is the one that defines, to a large extent, the functional profile of the respective community.

The distribution of employed population on the three sectors of activity highlights the profound rural character of the Underprivileged Mountain Area. Therefore, the proportion of population in the primary sector is 48,3%, value which demonstrates the economic dependence on agricultural activities of the population. As it can be noticed, (figure 5) in the studied territory there are differences at the level of units. The highest level is registerd in Șinteu commune, 85,5%, a reflexion of its economic past and present, centered on agricultural activities. Except for the three towns Aleșd (9,2% the lowest value), Nucet and Vașcău, only in three communes the values are under the average: Finiș, Lunca and Șuncuiuș.

The population employed in the secondary sector, 4092 people, represents only 16,4% from the employed population. This value is disproportional compared to the existent natural resources which allow the development of this activity. An important role in this value, is taken by the changes occurring in industry in the post communist period. The most remarkable values are registered in the towns Vașcău (31,9%), Aleșd (30,8%), Nucet (23,8%), as an effect of the existent industrial tradition and European Food and European Drinks industrial platforms. In the rural area, we can notice the communes Lazuri de Beiuș, Lunca and Pietroasa with over 20%, an effect of the above mentioned industrial platforms located in the vicinity.

The tertiary sector represents 35,3% of the entire employed population. The proportion of employed population in this sector has registered constant increases after 1990, free economic enterprise being no longer forbidden. We have to mention the fact that the employed population plays an important role in public services, followed by constructions, commerce, tourism. The highest values are registered in the towns Aleșd (60%) and Nucet (59,2%), located far away from the other territorial units. These values are the result of their town status and activities in the fields of commerce, tourism, construction. The tourist activities are seconded by the commercial ones in the communes Șuncuiuș (54,6%), Bratca (39,1%), Bulz (36,1%) and by constructions in Finiș (42,7%), this fact placing these communes with values above the overall average. In the other administrative units, the registered values are inferior or close to the overall average.

The population level of education is of primary importance in the qualitative definition of population and workforce, in particular. Out of the total population of 10 and over, the highest proportion 66,7% is registered by the population with secondary studies, 18,3% primary studies, 7,3% higher education 3,3% post-secondary and vocational, and a percentage of 4,4% has no

studies (figure 6). These values reflect on the field the aging demographic process, the predominantely rural character of the area and the economic specificity.

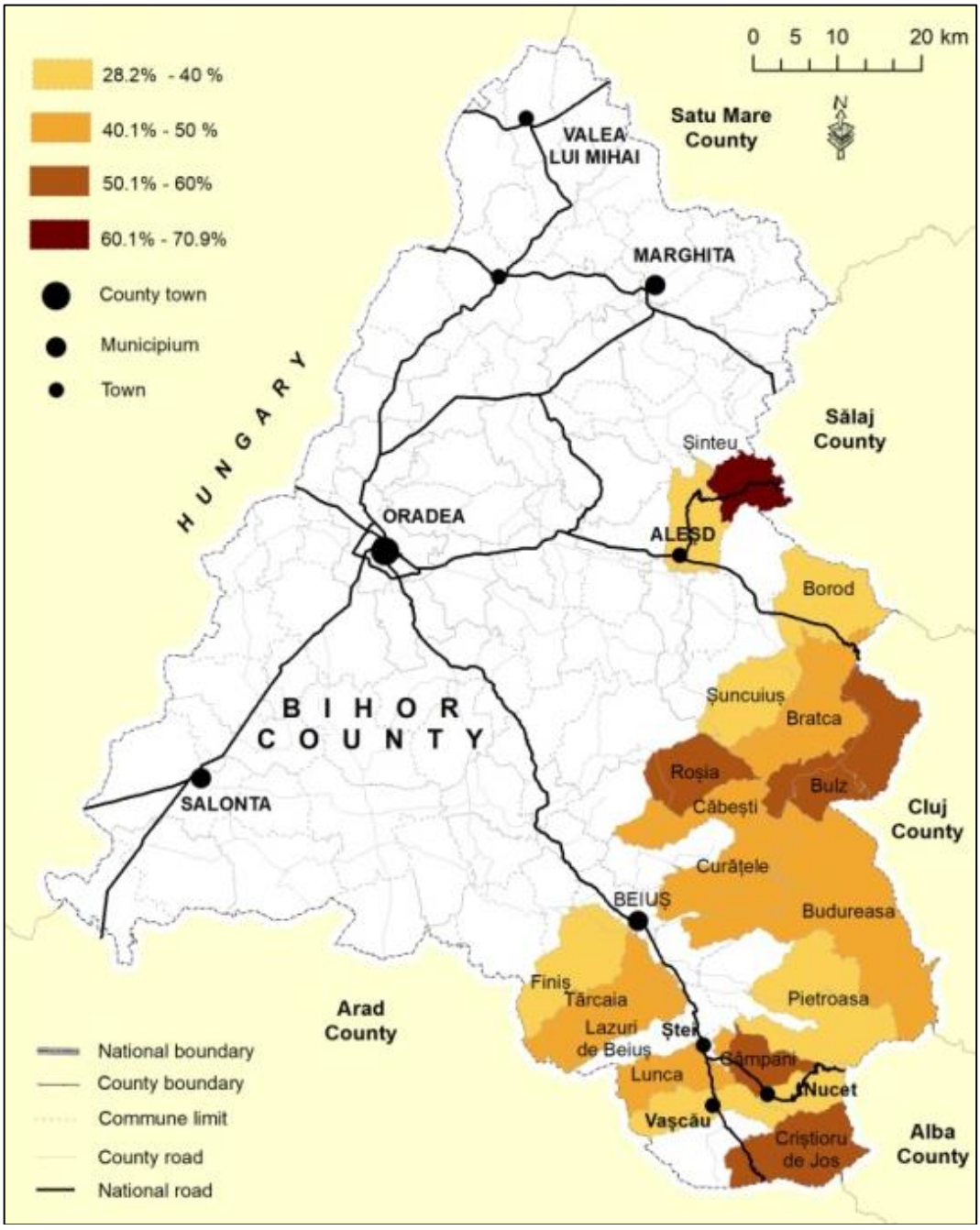

Figure 4. The proportion of employed population

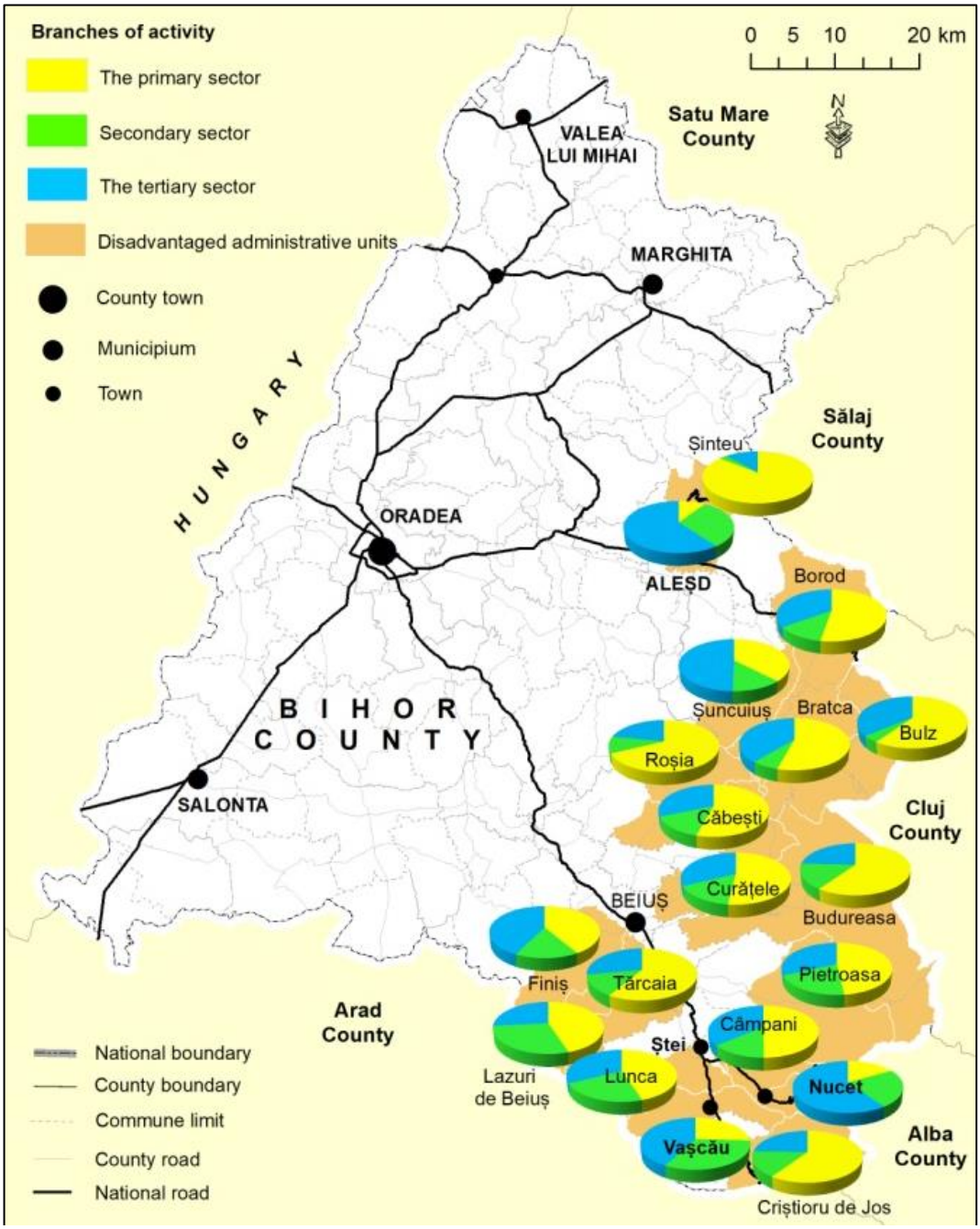

Figure 5. The employed population on sectors of activity

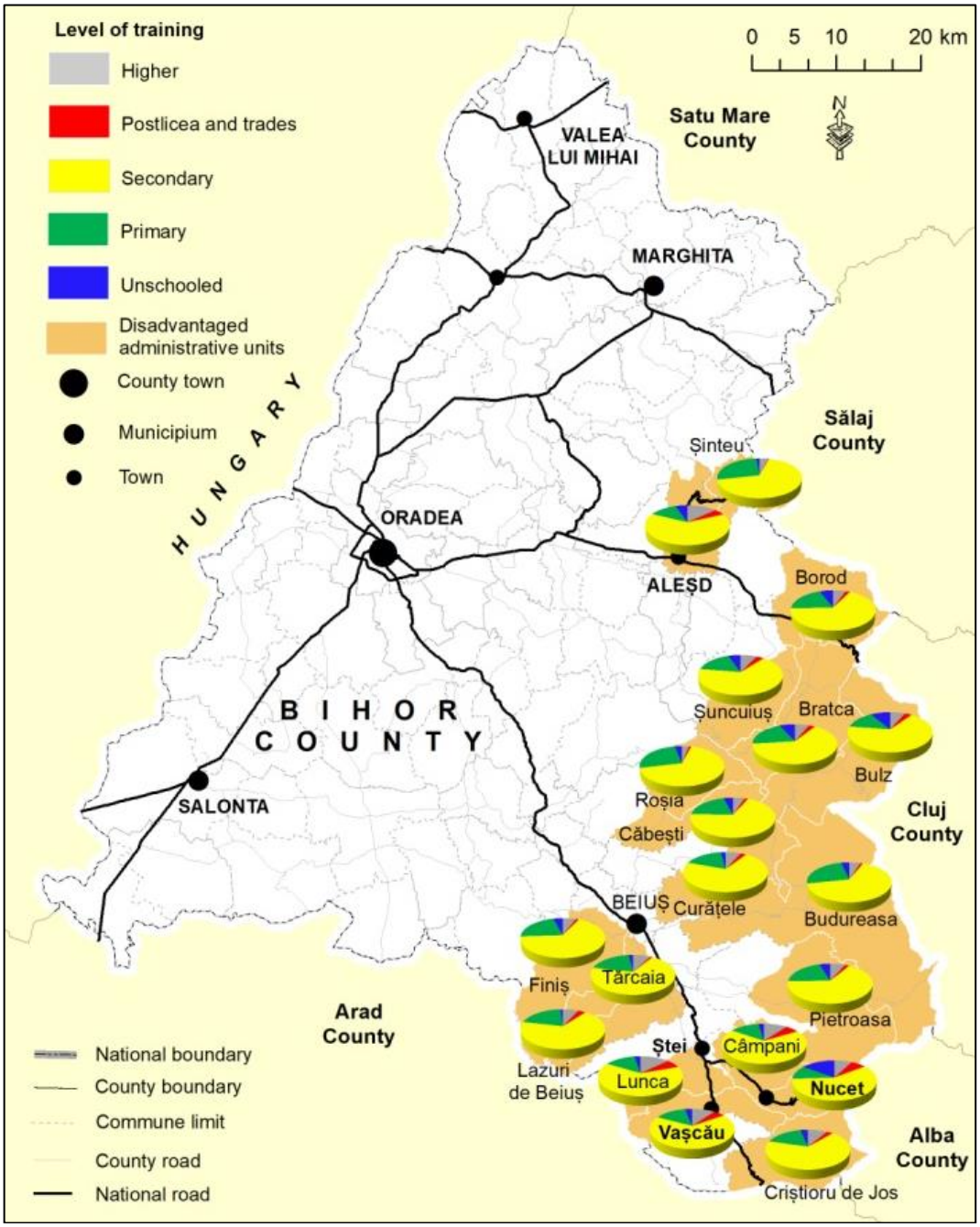

Figure 6. The population level of education

The people with *secondary studies* (high school and middle school) register the highest values in Curățele commune, 71%, on the opposite side being the town Nucet with 59,6% from the population of 10 and over.

A number of 4090 people, 7,3% respectively attended higher education. The low percentage is normal for a mountain area, generally seen repulsive by those with higher studies. In addition, the

existent economic activities do not require such studies. Values above the average are registered in Aleșd (13,1%), followed by Vașcău and the communes Lunca and Câmpani, with over 10%. Post-secondary and vocational studies do not register important proportions, 1661 people, or 3,3% respectively. Higher values are recorded in the towns Nucet (6,7%), Vașcău (5,1%) and Aleşd (5%), and among the communes Lunca (6,7%) and Câmpani (6%) have been noticed.

8854 people attended *primary studies* who represent 18,3% of the population of over 10 years old. At territorial level, the highest value is registered in Șinteu, 27,1%, and the lowest value is recorded in Nucet with 11%.

The lack of studies characterises a number of 2435 people, 4,4% of the population of school age. The territorial units where the illiterate people register higher proportions are either more isolated with a larger elderly female population Bulz (8,8%), Bratca (6,8%) or communities with a significant number of gypsies/Romani people such as the one from the commune Șuncuiuș (5,4%).

CONCLUSIONS

The analysis of the human capital in the Undeprivileged Mountain Area of Bihor county allows the sketch of an overview and the emphasis of some significant aspects, which place the human resources close to the demographic specificity of the county.

Quantitatively, we can state that the population volume is low compared to the natural potential and the dwelling capacity offered by the mountain area in Bihor county. Another relevant aspect lies in the fact that, in number and density, the population does not represent a pressure factor on the mounatin.

Regarding the quality of the human resources, it can be noticed a certain balance between the two genders, more male inhabitants than female being present in few administrative units (Roșia, Căbești).

The distribution of population on age groups highlights the fact that the recorded values by the three main groups are within the normal values recorded at county level. The process of demographic aging, at least for now, is not significant and does not endanger the existence of communities.

The employed population and its distribution on sectors of activity emphasise the rural character of this area and its high dependence on the activities in the primary sector, the non-agricultural activities being less present.

The level of education is according to the needs in underprivileged mountain areas and it contributes to the emphasis of the predominantly rural character of this space.

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TOURISM DEVELOPMENT IN YUANTONG ANCIENT TOWN

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Abstract: The aim of this article was to find out if the tourism development in Yuantong town is satisfactory for both the locals and visiting tourists. The survey method was used and two different questionnaires were drafted and then filled by the two aimed groups. One questionnaire was for locals and one for visitors. The end results show that both groups are pleased so far with the development of the town and while not everyone shared the same views and opinions, the majority were satisfied with how the tourism industry is developing and growing in Yuantong ancient town, China.

Key words: survey, toursim development, ancient town, local economy

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INTRODUCTION

This survey took place during a period of two days in Yuantong Ancient City (figure 1 and 2) and it involved a series of questions split in two questionnaires. By definition a survey is: "the collection of information from a sample of individuals through their responses to questions" (Check and Schutt, 2012). One questionnaire had questions designed for the local community and the other questions for the visiting tourists. A total of 58 questionnaires were filled by locals and another 59 by visitors. This method of research was used because there is not enough local data made public to show the effects tourism is having in Yuantong Ancient Town.

Many town houses and heritage buildings along with other monuments were restored and infrastructure was improved in order to make this location a touristic spot (figure 1 and 2).

The respondents were randomly selected, there was no criteria based on which they were approached for both questionnaires. There is no notable difference between all those approached that agreed or did not agree to participate except for the fact maybe that more older persons, who looked to have an age past 65, refused than younger persons did. But not many were approached because the majority of visitors and workers in Yuantong were younger. A lot of the visitors were accompanied by at least 2 more persons, and some groups were larger than 5. In many cases, each group had at least one child or teenager in it. This suggests that this town is preferred by families. The results of the questionnaires also showed that because all respondents said there are accompanied by family or friends, where those that were visiting with family were considerably

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more. Overall the local community said that Yuantong is a good place to live, even for young people and there are not many problems faced by the community. More than 60% said that they are currently pleased with the way Yuantong was developed as a touristic attraction and around 20% were undecided. But more than 50% consider that there are not enough tourists visiting their town. Only 25% of the respondents said that their family income relies on tourism. More than 50% consider the government involvement satisfactory and a lot more agree that the buildings are well preserved and restored. Over 70% of respondents from the local community agreed or strongly agreed that tourism contributes to the local community by creating jobs, increasing spending in the local businesses, supports local shops, museums, festival, events and heritage sites, helps maintain local tradition and identity and attracts investments into the area. The main problems the locals are facing are the lack of jobs or economic opportunity according to 25% of respondents and low wages mentioned by 15%. The lack of cultural amenities was also an issue for 15% and poor educational opportunities for 10%. 25% of respondents said that none of the mentioned are a problem.

The visitors on the other hand were asked about how pleased they were with their visit and more than 70% said that the trip to Yuantong met their expectations. Almost all respondents were visiting for just 1 day, half day or 2-3 hours, were accompanied by either family or friends and 90% of them were from the Sichuan province and arrived there by car. More than 60% were workers and closet to 20% students. Almost everyone was visiting Yuantong for rest and relaxation. More than 90% said this was their main visiting reason. More than 50% of respondents declared to have spent between 50 to 100RMB per person per day on food, shopping and other activities. All of this data shows that Yuantong Ancient Town is a destination for families that live in the nearby cities in the Sichuan province that arrive by private care to spend a relaxing day and then return back home later that same day. When asked to evaluate the overall attractiveness of the town, the quality of restaurants and cafes, and the local attractions, almost all statements received more than 70% ratings ranging from good to excellent. In general, the tourists seemed very relaxed and happy enjoying their day together with their families and friends and were pleased about Yuantong and its restaurants and local attractions.

Figure 1. Yuantong Ancient Town riverbed side

Figure 2. Yuantong Ancient Town-Huijiang Bridge

BACKGROUND AND OBJECTIVES

This research could be necessary in order to determine if the development and restoration of the ancient town was and is satisfactory for the local community.

The tourism economic impact plays a major role because of the many tourists that spend money in Yuantong town or other similar locations and affect the income of the local businesses be it directly or indirectly (Research Resolutions & Consulting Ltd, 2007).

It is also important to know if the influx of tourists visiting has led to an increase in the quality of life of the local community or if it has turned things for the worse. This is important to ensure the long-term success of this smaller attraction that lies on the outskirts of the city of Chengdu. There are multiple small ancient towns in proximity of the city and Yuantong must

compete with all of them to attract tourists. Jiezi ancient town must be in particular taken into consideration because it is very close to Yuantong and it is a much bigger town with many more shops, hotels and restaurants. So Jiezi could be the more obvious destination to travel to. These ancient towns are very good weekend destinations for the people that live in, or close to, the city of Chengdu or other smaller, but still developed cities that are close. So, it is also important to determine through research such as this one if the tourists that visit Yuantong have a good experience and enjoy their stay in this ancient town. Any issue found should be addressed in the future in order to ensure the long-term survivability of this ancient location as a touristic destination.

The first objective of this study was to get a basic understanding of the impact tourism is having on the local community. To understand if they are pleased with the fact that Yuantong has become a touristic attraction, to know how they profit from this fact and see if they think and feel about how tourism contributes to life in their community. The impact tourism is having on smaller communities is a concern raised in various papers (Allen et al., 1988; Mahony and Van Zyl, 2002; Leon, 2007; Gabriel Brida et al., 2011; Herman et al., 2017, 2018a; Ilie et al., 2017).

The second objective was to receive feedback from visiting tourists and understand their preferences and why they chose to spend their day in Yuantong. It is necessary to understand their needs so that future development can also take these into consideration to ensure the long-term prosperity of this town as a touristic attraction.

METHODOLOGY

This survey was performed to study the tourism development of a certain area in a similar fashion other surveys were conducted for much the same reasons in different towns and areas (Tyrrell et al., 1984; Sheldon and Var, 1984; Rønningen, 2010; Johnson, 1994; Chhabra et al., 2003; Ritchie and Inkari, 2006; Miller, 2003).

Various research methods using surveys can be found throughout many different studies and papers (Ritchie, 1988; Lankford, 1994; Sinclair, 1998; Snaith and Haley, 1999; Simmons, 1994; Ilieș et al., 2015; Bar et al., 2016; Herman et al., 2018b; Wendt et al., 2019).

In order to determine how beneficial, the tourism development of Yuantong ancient town currently is, from the point of view of the locals and visitors, the method used to collect data was face-to-face interview survey using printed questionnaires.“Face-to-face interviews involve the researcher approaching respondents personally, either in the street or by calling at people’s homes. The researcher then asks the respondent a series of questions and notes their responses.” (Kelley et al., 2003). The main reason this method was select is because there is not enough available public data to draw conclusions regarding this research. The survey took place mostly on a Sunday when visitors were engaged and the following Monday when a portion of the questionnaires for local were filled.

“A questionnaire is the main means of collecting quantitative primary data. A questionnaire enables quantitative data to be collected in a standardized way so that the data are internally consistent and coherent for analysis” (Roopa and Rani, 2012).

There were two types of questionnaires used, one for locals and the other for visitors. Both questionnaires were printed on A4 paper format, front and back, and feature a horizontal design. Questions were thought of to be easy and fast to reply to and mainly focused on the satisfaction of the local community and visitors regarding the touristic development of the ancient town. It was important to find out if visitors could access the location quick and easy and if they found everything they wanted and needed once there. Information about if all their needed were suited was most important. For the local community a different set of questions were designed from which it could be later concluded if the development of the ancient town as a touristic destination has improved their quality of life, if they are satisfied with the current situation, the amount they earn, the number of tourists visiting the ancient town and if their earnings are related to touristic activities.

The survey was completed in 2 days and a total of 117 questionnaires were filled. 59 questionnaires by locals and 58 by visitors. The survey took place inside the ancient town area. Because this is more of a weekend destination, Sunday was selected to ensure there are enough visitor to approach for this survey and the rest of the remaining questionnaires intended for locals were filled in on Monday. There were no criteria on which the tourist respondents were selected other than the fact that they had to be visitors who were not living in Yuantong.

The questionnaires for locals were mostly filled by owners and workers of small businesses such as shops, restaurants and other services. These criteria were used to see the impact tourism had on this sector and on the local economy.

Figure 3. Yuantong Ancient Town riverbed side

Figure 4. Yuantong Ancient Town centre

There were 58 questionnaires filled by visitors. There was no identification process used. People were approached on the street, in restaurants and shops and were asked if they are visitors and wish to participate in a quick survey. This was the approach used for each respondent and if the answer was no, no other attempts were made to try and convince this person. Only one attempt was made every time. Around 70% to 80% of the persons approached agreed to take part in the survey and most were very glad to do it. There is no notable difference in gender or other demographic criteria observed between the respondents and those who did not wish to fill in the questionnaire. It was observed that some of those who declined were over the age of 55, but this cannot be determined for sure. Most of the persons approached were in groups larger than 3 persons which indicates that this is more of a family destination. A large number of respondents of the visitor survey had kids with them. This questionnaire for visitors proved to be good because it took almost everyone only 3 to 4 minutes to complete. It included question such as why are they visiting the town, if the location met their expectation and asked them to rate the quality of different locations they have experienced, restaurants they ate in and the services that were provided on site.

The other 59 questionnaires were specifically designed for and filled by people from the local community. The identification process required these persons to live, work or own a business in Yuantong ancient town. The response rate was much higher for this questionnaire. Around 90% of the people approached were happy to respond and many were quite glad they could be a part of this research. All were approached in their shop or street stall where they were working. There is also no notable demographic difference regarding the 10% that did not wish to be a part of the survey. A few had to refuse because they were busy serving customers. Also, it was noticed that more females responded to this questionnaire because a lot of the business owners and employees of the places we went into or street stalls we stopped at were of this gender. This questionnaire proved to take longer to fill and each respondent spent at least 10 minutes answering the survey questions. The people from the local community were asked to answer questions such as if their family income relies on the local tourism, if there are enough tourists visiting and to rate how tourism affects their lives having multiples answers to give a grade to from 1 to 5.

RESULTS

RESULTS TARGETING THE LOCAL COMMUNITY

The local community was very responsive when asked if they would like to participate in a survey regarding tourism development in Yuantong Ancient Town. Around 90% of those who were asked were very receptive and gladly agreed to fill in the questionnaire right away. It was found that 90% of the respondents are residents but only 20 declared that their family's income relies on the local tourism, that means that 35% of the locals that replied profit and depend on the number of tourists visiting their town. When asked if this number is large enough, if there are enough tourists visiting Yuantong Ancient Town, 39 replied with no and 20 with yes (figure 5).

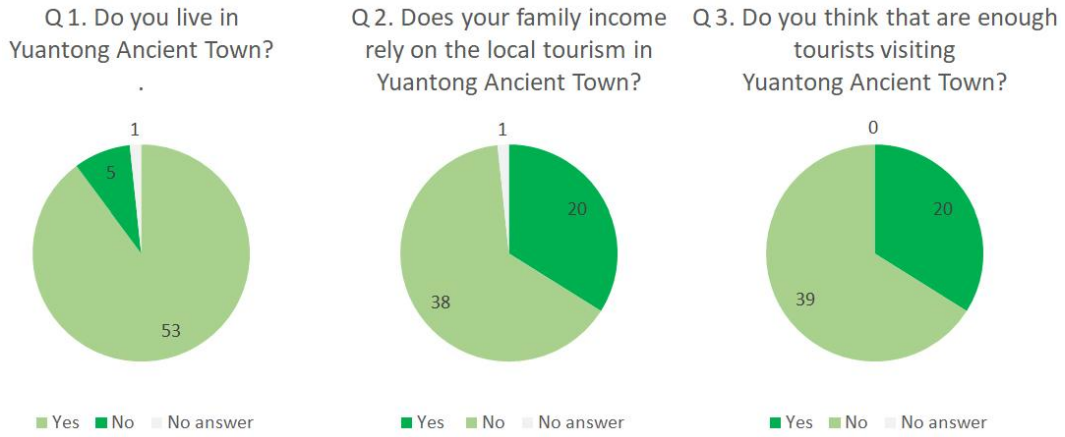

Figure 5. Question 1,2 and 3 from the questionnaire targeting the local community

Question 4 on the questionnaire had a series of statements that the respondents had to select how much they agree or disagree with each sentence. The overall response was a positive one and more than 50% agreed or strongly agreed with most of the positive statements. More 20% remained undecided for most of these affirmations. 75% of the people agreed with more of them selecting that they strongly agree that Yuantong is a good place to live. For the statements: There is not much for your people here and that the local community faces a lot of problems living here, results were fairly similar with around 50% of the respondents saying that they disagree or strongly disagree with these statements, with another 25% saying that they are undecided. There were a few persons that chose not to answer, which left only 22% agreeing out of which only 4 strongly agreed.

Asked if the quality of life has improved since the tourism development, more than 50% agreed or strongly agreed, where 25% remained undecided. But almost 60% remained positive and agreed and strongly agreed that future prospects for the area are good. 25% remained undecided and very few did not agree. More than 50% also agree that the tourism industry has good relationships with the local community but it should also put more back into the local community. 20% remained undecided (figure 6).

The most positive responses regarding this set of statements were received when asked if they agree or disagree that tourism is important for the long-term prosperity of the local community and that old heritage buildings are well preserved and properly restored. Around 80% agreed or strongly agreed and only a few did not agree. The rest, up to 15% remained undecided.

The fact that the government involvement was satisfactory for the development of the area was also agreed upon by more than 50% of the respondents and 25% remained undecided. Only 20% did not agree with this statement.

Figure 6. Question 4 from the questionnaire targeting the local community

The last in this series of affirmations was that the tourists who come to Yuantong town cause damage to the environment and more than 60% did not agree or strongly disagreed with this and 25% remained undecided. Less than 10% agreed (figure 6).

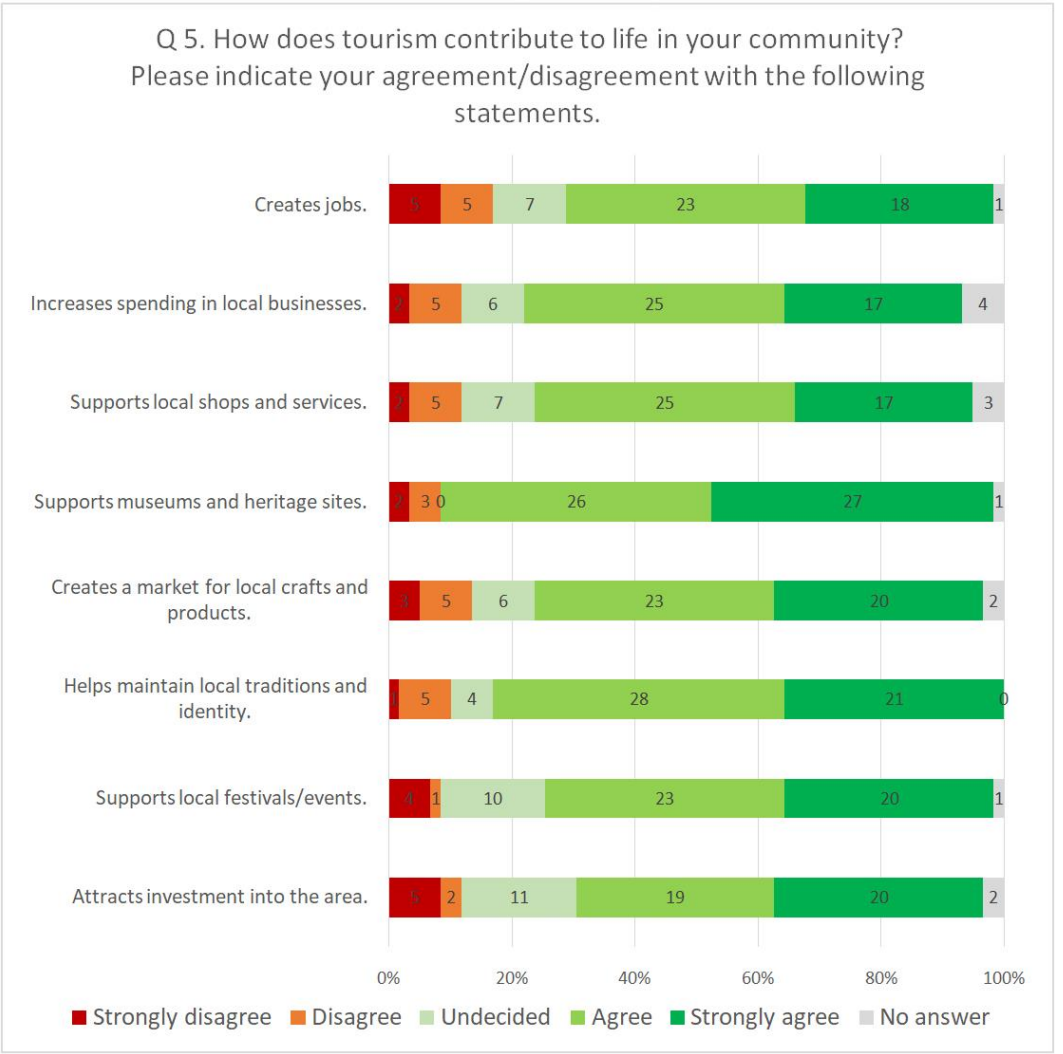

Figure 7. Question 5 from the questionnaire targeting the local community

The following question (figure 7) was how does tourism contribute to life in the local community and again a set of statements were given for the respondents to agree or disagree with. In this case, everyone agreed a lot more with all of the positive affirmations listed. More than 70% agreed or strongly agreed with the facts that tourism contributes by creating jobs, increases spending in local businesses, supports local shops and services, supports museums and heritage sites, creates a market for local crafts and products, helps maintain local traditions and identity, supports local festivals and events and attracts investment in the area. Around 10% or more remained undecided and for most questions a little over 10% did not agree or strongly disagreed. Only very few chose not to give an answer for this question. The fact that tourism contributes by supporting museums and heritage sites was the only statement that did not have any undecided respondents and less than 10% disagreed. The rest of 90% agreed or strongly agreed, and just 1 person did not answer (figure 7).

When asked if the problems listed (figure 8) are present in their community, the results were mixed. 25% selected that the lack of jobs and economic opportunity is a problem. More than

10% said that low wages are a problem and the following statements were also selected by more than 10% each: Lack of cultural amenities and poor educational opportunities. A little over 20% of the respondents stated that none of the mentioned affirmations are a problem and 20% said that there are other issues in their community. None suggested any of these other problems. 4 chose not to answer (figure 8).

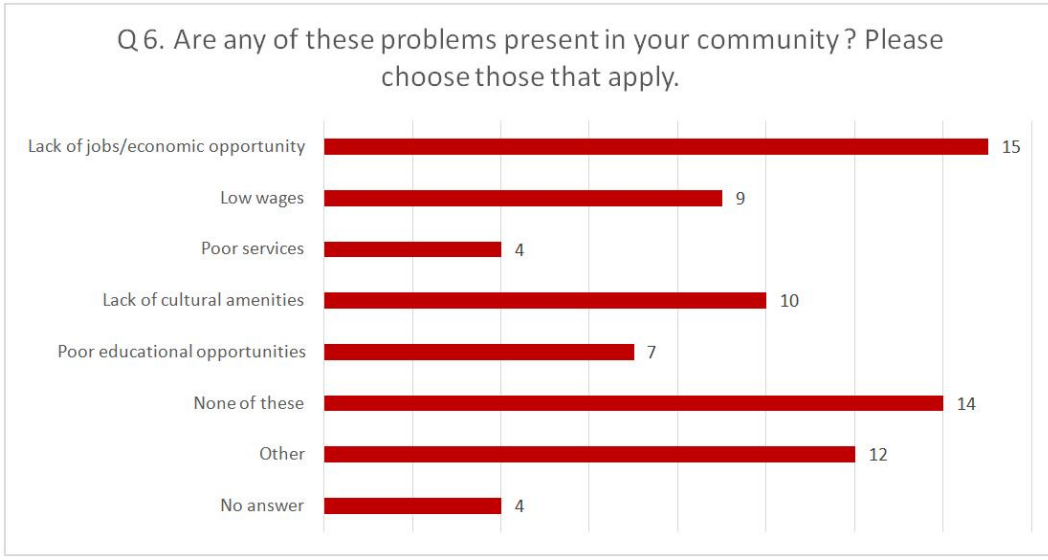

Figure 8. Question 6 from the questionnaire targeting the local community

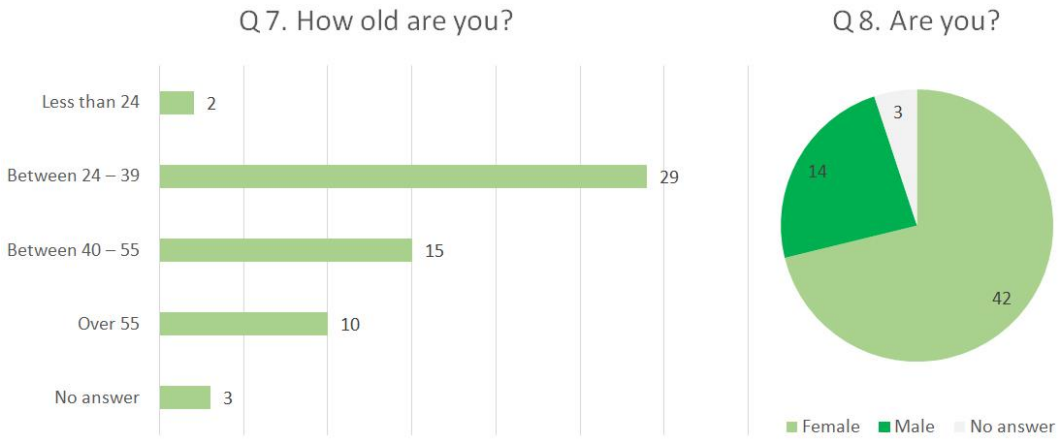

Figure 9. Question 7 and 8 from the questionnaire targeting the local community

Out of the 58 respondents that filled in the questionnaire 42 where females and only 14 were males. 3 did not answer. Out of these, 29 declared to have an age between 24 to 29, 15 between 40 and 55, 10 people over 55 and only 2 had an age of less than 24. 3 chose not to answer (figure 9).

SURVEY TARGETING THE VISITORS

There was a total of 59 respondents that answered the questions of the questionnaire intended for visitors. Out of these, 33 had an age between 24 and 39, 7 between 40 and 55, 14 were under 24 years old and only 3 were over 55 years old. 90% said that they are from the

Sichuan province, 2 from Zhe Jiang, 1 from Guang Dong, 1 from Shan Dong and 1 did not answer (figure 10 and 11).

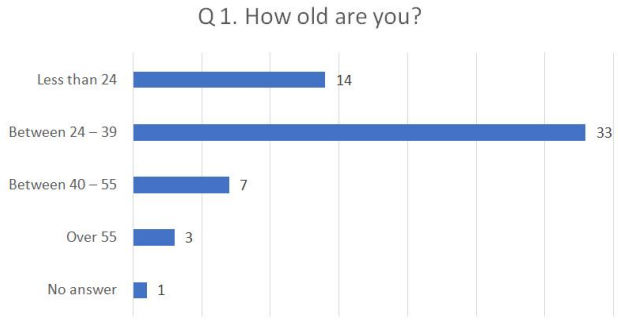

Figure 10. Question 1 from the questionnaire targeting the visitors

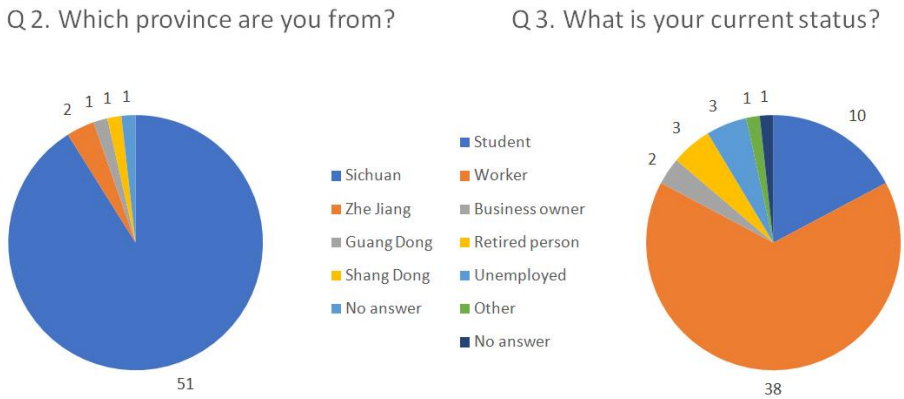

Figure 11. Question 2 and 3 from the questionnaire targeting the visitors

When asked about their status, 65% declared that they are workers, 15% said that they are students and the remaining 20% said they were unemployed, retired, business owners or other. 1 did not answer this question (figure 11).

The top main reason, chosen by more than 90% of the respondents, for visiting Yuantong Ancient Town was rest and relaxation. 3 were visiting or meeting with relatives or friends. 4 said they were visiting for culture and festival and another 3 for walking and nature (figure 12).

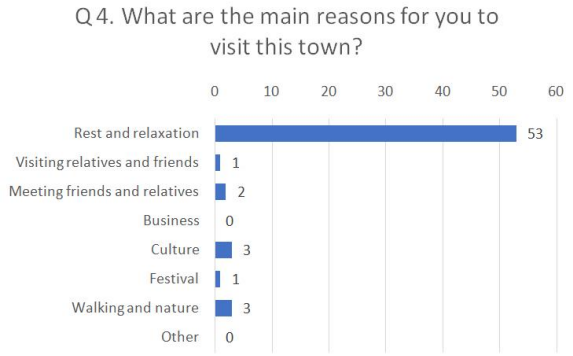

Figure 12. Question 4 from the questionnaire targeting the visitors

When asked about how did they found out about Yuantong town, 24 said that they already knew of it, 23 chose the internet option and 13 said they know of it from friends and relatives. Only 1 chose the media option and 1 chose travel agency. None reported to have known about the town from books or guides (figure 13).

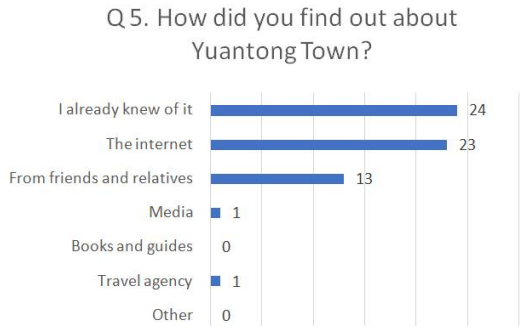

Figure 13. Question 5 from the questionnaire targeting the visitors

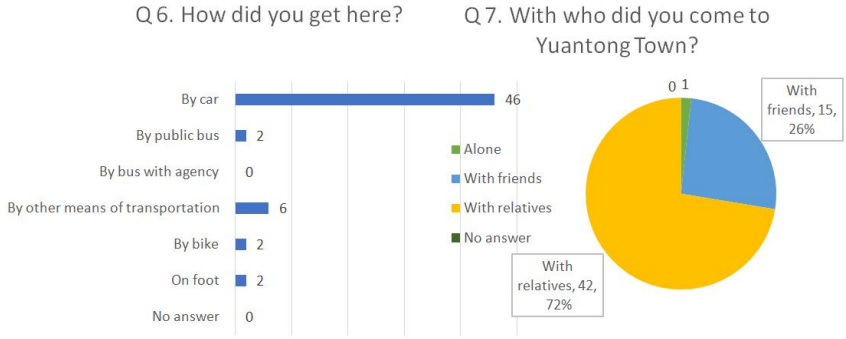

Figure 14. Question 6 and 7 from the questionnaire targeting the visitors

72% of the respondents declared that they are visiting the town accompanied by relatives and family and 26% with friends. Only one person said to be visiting alone. Out of these, 46, which is more than 75% said that they arrived there by car. 2 chose the public bus option, 2 arrived by bike, 2 on foot and 6 said that they arrived by other means other than the ones listed (figure 14). 70% declared that they are visiting for a full day and 12% selected the half day option. 6 were there for only 2 or 3 hours. Only 1 person said that the visit length is 1 to 2 days. 4 chose not to answer (figure 15).

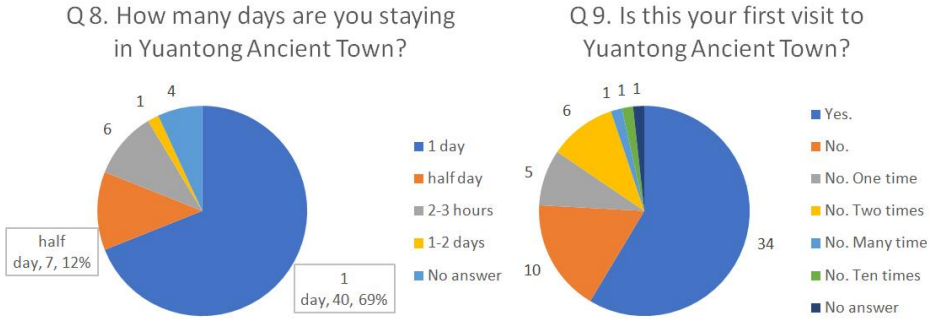

Figure 15. Question 8 and 9 from the questionnaire targeting the visitors

Asked if this was their first visit to Yuantong Ancient Town, almost 60% replied with a yes. 15% said no. 1 person had already been there one more time, 6 had previously been there 2 times before, 1 many times, 1 ten times and 1 did not answer (figure 15).

Regarding the annual net income of the respondents, the results vary. Out of the 59, 17 said that they earn between 60.000 to 100.000RMB, 12 between 30.000 and 60.000RMB, 14 under 30.000RMB and 7 said that they earn more than 100.000RMB. 8 persons chose not to answer this question. The next question was regarding now much money they have spent during their visit in Yuantong Town per person, per day on accommodation. More than 30% said to have spent less than 100RMB and 30% more than 100 to 300RMB. 20 did not answer this question (figure 16).

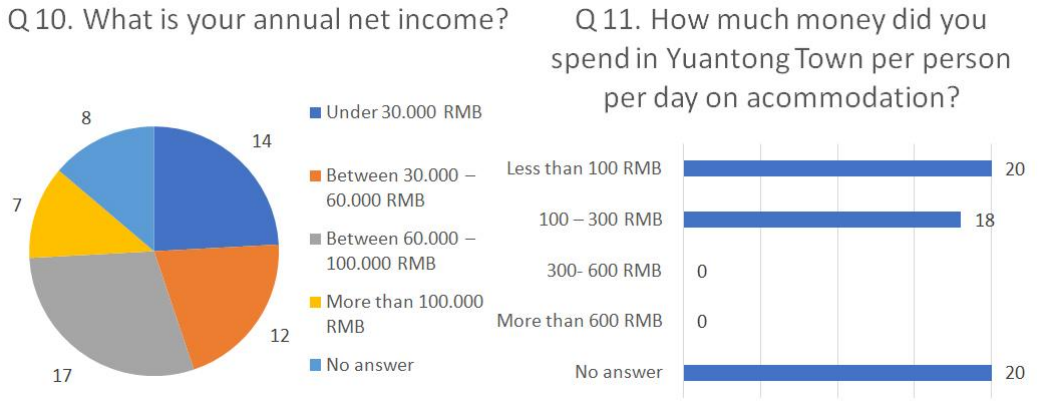

Figure 16. Question 10 and 11 from the questionnaire targeting the visitors

As a follow up, they were also asked how much money they had spent per person, per day on food, shopping and other activities. More than 50% reported to a spending of 50 to 100RMB, 14 spent 100 to 200RMB, 5 more than 200RMB and 7 said that they have spent less than 50RMB (figure 17).

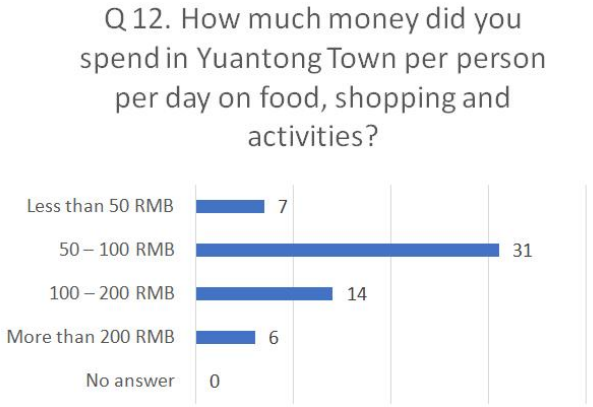

Figure 17. Question 12 from the questionnaire targeting the visitors

The following questions were to ask the respondents to evaluate with reviews ranging from poor to excellent the quality of accommodation, restaurants and cafes, the overall aspect and accessibility of the town and different touristic attractions that can be found on location. Regarding the quality of their accommodation, more than 50% replied with answers ranging from good to excellent, 10% chose the poor option and more than 30% did not answer. The quality of

restaurants and cafes along with the overall aspect of Yuantong town received positive feedback where most chose the good or very good option and a few, under 10%, chose excellent. 10 did not state their opinion about the quality of restaurants and cafes and a little over 10% chose the average option in both situations. Only one person rated the quality of restaurants and cafes as poor. The overall aspect of the town had the most positive feedback where 85% replied with good, very good and a few with excellent. Concerning the accessibility of Yuantong town by public transportation, more than 50% declared that it is good, very good and 10% chose the excellent option. 15% said that it is average from which one said that it is poor. 25% chose not to give a rating (figure 18).

When asked to evaluate the attractiveness of the enumerated local attractions which were: Catholic Church, Liu's Manor, Trading Hall, Pagoda and Xiejiang River, close to 70% rated each of these attractions as good, very good and excellent. Out of the 70%, close to 25% said that the attractiveness was good, around 20% said very good and close to 15% said rated with excellent. More than 10% rated the attractions with average and less than 5% reviewed their attractiveness as poor. More than 10% overall chose not to rate these local heritage buildings, monuments and river (figure 19).

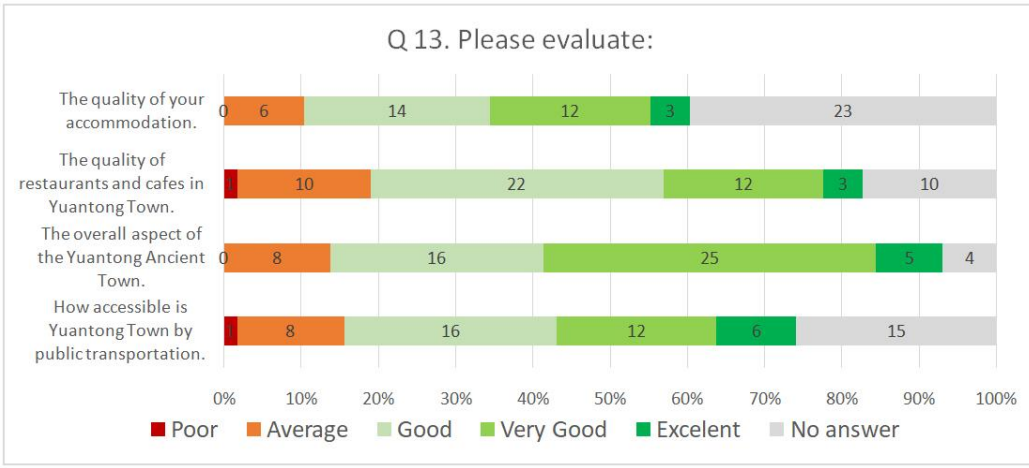

Figure 18. Question 13 from the questionnaire targeting the visitors

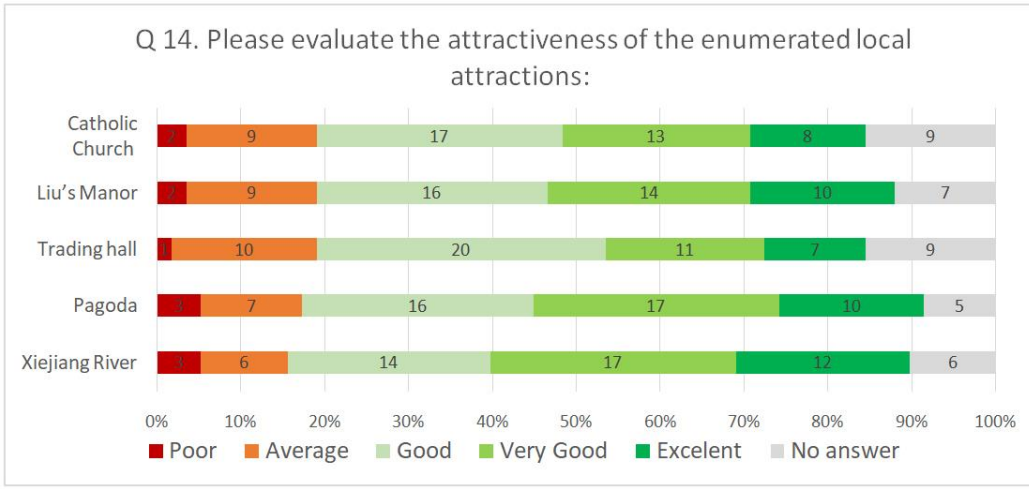

Figure 19. Question 14 from the questionnaire targeting the visitors

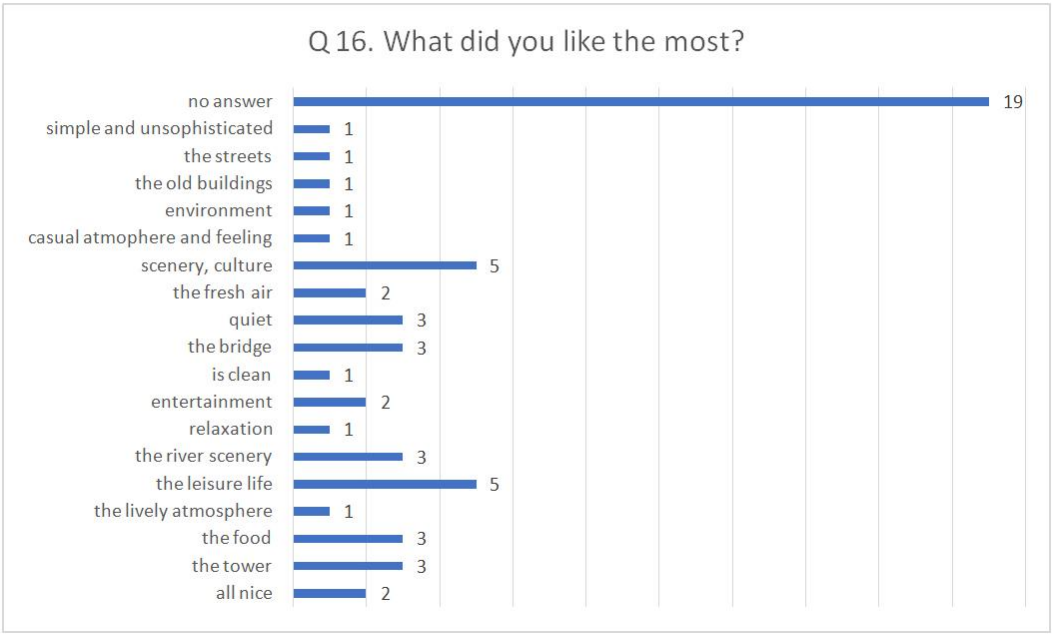

Figure 20. Question 16 from the questionnaire targeting the visitors

The last questions were about what did they like or dislike the most in Yuantong Ancient Town. Over 30% did not say what they liked most and among those who did, the most popular answers were culture, scenery and leisure life. The next most popular answers were the fact that is is quiet, the bridge, the food and the tower. Other things like the streets, old buildings, environment, casual atmosphere, clean, entertainment and fresh air were also mentioned. For the what did they dislike the most, more than 70% of respondents did not answer. Only 2 persons mentioned that they did not like the fact that the town was too small and another 2 mentioned that they did not like the weather. Inconvenient parking, tea too expensive, a little untidy, toilets, too commercial, inconvenient transport, some attractions being closed and the fact that the tea houses built on the side of the river are obscuring the original natural look were also each mentioned once.

Overall, 79% or respondents said that their trip to Yuantong met their expectations and only a little over 10% said no. less than 10% did not answer this question.

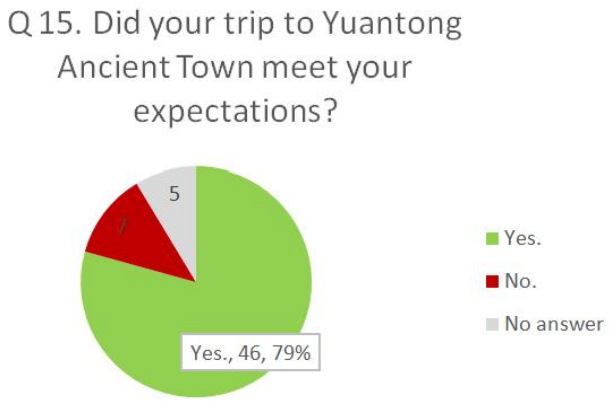

Figure 21. Question 15 from the questionnaire targeting the visitors

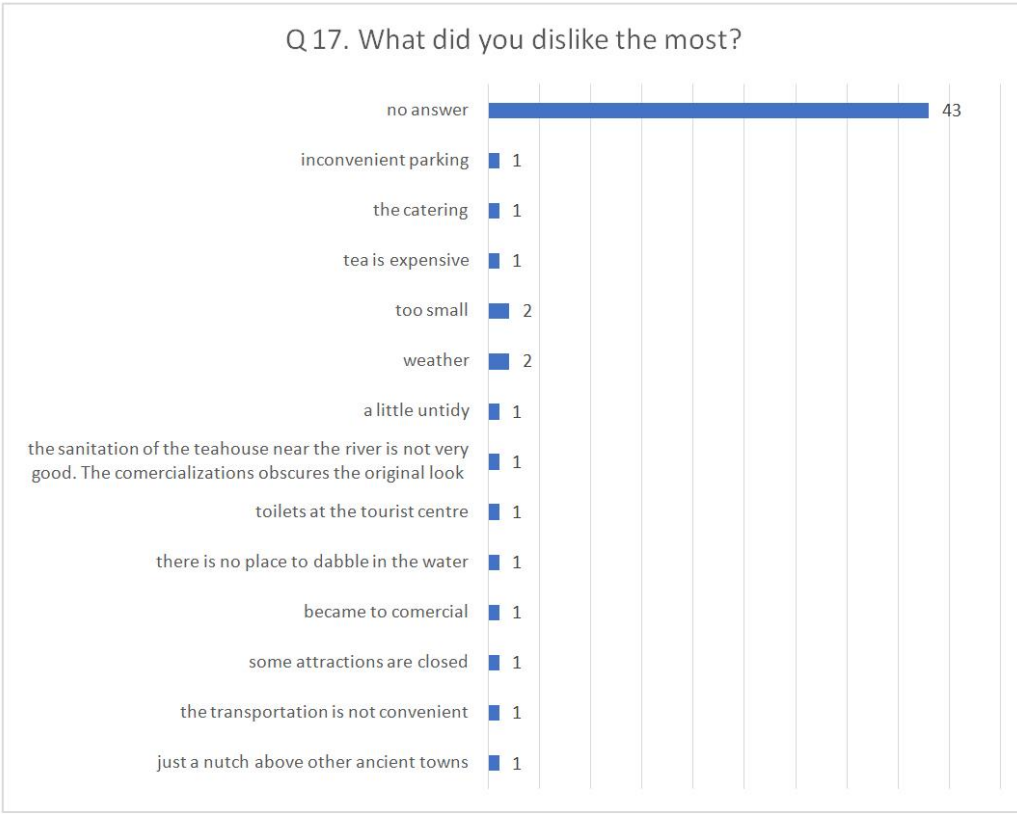

Figure 22. Question 17 from the questionnaire targeting the visitors

CONCLUSION

Survey Targeting the Local Community

In conclusion the local community was much more receptive and curious about the survey. Most of the people who participated are residents of the town. But only a little over 30% of them said that their family income relies on local tourism. So more than 60% of the locals are still not dependent on the number of tourists visiting. Also, a little more than 30% considered that there are not enough tourists visiting Yuantong and the rest of more than 60% said that there are enough. Most of those who rely on tourism fortheir family's income have also stated that there are not enough tourists visiting the ancient town.

Overall the respondents consider Yuantong Town a good place to live and also around 50% of them disagreed or strongly disagreed with the fact that there is not much for young people there and that the local community faces a lot of problems living in this town. Another 25% remained undecided and only around 20% agreed with these statements. In the view of the local community, Yuantong still has a lot to offer, even for the younger generations and many considered that they do not face a lot of problems living there.

Regarding the quality of life, the answers suggest that it has improved a lot since it has become a touristic spot. Future prospects are also very promising for the local community and more than half agreed to this. Some remained undecided and only a few did not agree. But people also consider that the tourism industry has good relations with the local community and that it should also put more back into it. So, the people have high expectation regarding the tourism development, the long-term development and how much they profit from it. More than 70% agreed or strongly agreed that tourism is important for the long-term prosperity of the local community

Figure 24. Yuantong ancient town – trading hall

Figure 25. Yuantong ancient town – Pagoda

Many of the houses were rebuilt and restored in Yuantong town, along with the monuments, old heritage buildings and the bridge as part of the plant to develop tourism and make this town a destination worth visiting. And most of this was done with a lot of assistance from the government. More than 50% of respondents agreed that the government involvement in this matter was satisfactory, where 90% said that the old heritage buildings are well preserved and properly restored. This could suggest that the government, in some of the respondent's opinion, could do more for their community other than restoring the ancient town buildings and monuments. But this could not be the case since regarding this matter only 20% said that the involvement was not satisfactory and another 20% remained undecided. The local community is also satisfied with the visitor's behavior and most consider that the tourists that visit their town don't cause damage to the environment. Only less than 10% agreed that they do.

Tourism seems to become more and more important for a town such as Yuantong. Most respondents agreed that tourism contributes by supporting and increasing the local economy. Facts such as tourism helps create jobs, increases spending in local businesses, supports local shops, services, museum, heritage sites, festival and events and last but not least, attracts investment into the area, are very important. More than 70% of respondents agree to this and even if only a little over 30% declared that their family income relies on local tourism, a lot more agree how important tourism actually is for the entire local community.

According to 15 persons, there is a lack of jobs and economic opportunity in Yuantong. 9 others suggested that the wages are low. Some said that their community has poor services and poor educational opportunities and another 10 people indicated that there is a lack of cultural amenities. 14 people reported problems other than the ones listed but did not mention what. These responses show that there are still some issues in an area such as this one and even if the recent development has brought in a lot of tourists, not all problems have been fixed as much as the local people are concerned. The lack of jobs or jobs with low wages are the main concern for the locals where the lack of cultural amenities and education come in second. Only 25% of the respondents said that none of the listed issues are a problem. This leaves more than 70% that worry about certain issues that their community is facing.

Almost 70% of the respondents for the local community survey were females. This was in no case intentional. This just shows that there are more women working and interacting with the tourists in the shops and restaurants in the Yuantong Ancient Town than man do. It was observed that there were more men working in the kitchens of the restaurants in the central square but these were not available for the survey as they were busy with their jobs. Among all of the local people who were approached and also replied, only 2 persons were under the age of 24 and most were young adults having ages ranging from 24 to 45, and these were around half of those who were part of the survey, where the rest where middle-aged women and men with ages starting from 45 to 65.

Survey Targeting the Tourists

People that were visiting and agreed to be a part of the survey were mostly under the age of 40. This was not intentional. More than 50% were young adults and 25% were adolescents. It was observed that the tourists arriving into town were mostly young adults accompanied by children or teenagers and some older people. Almost all respondents were from the Sichuan provice and were workers and some students. Rest and relaxation were the main reason for their visit. This shows that Yuantong is a destination mostly for working people who are looking for a good place to relax and spend the weekend with their family and friends. Most of the people that were approached were in groups of at least 3 people and some in groups larger than 5. More than 70% did declare that they are visiting accompanied by relatives and 25% by friends.

Yuantong seems to be a good destination for the weekend. This results from the fact that almost all of the respondents declared that they are only visiting for a few hours, half a day or one day. 80% of the visitors arrived by car. All of this data results show that Yuantong is a destination that people from the nearby cities use a relaxation spot for a single day. Almost everyone said to have arrived there by car which can be an effective mean of transportation to access such location and return back home later that same day.

More than half declared that it is their first time visiting this town. A few said that they have been there one time before, others two times and 2 more than 10 times.

The annual net income of the 59 respondents varies a lot. The results were equally split between people who earned less than 30.000RMB, to people who earned between 30.000 to 100,000RMB and those that had a net income larger than 100.000RMB. But the amount of money people spent was quite similar for everyone, per person per day. More than 60% declared that they have spent less than 100RMB and another 25% said to have spent between 100 to 200RMB. Only 10% spent more than 200RMB. People were also asked about how much they have spent on accommodation but it is unclear if they actually spent the night in a hotel or not because this was not asked. And since most declared to be visiting for just 1 day, the following data could not apply. More than 30% said to have spent less than 100RMB per person per day for accommodation and another 30% said 100 to 300RMB. 20 did not answer and this suggests that they did not spend the night in Yuantong. Again, when asked to evaluate the quality of their accommodation, 23 persons, more than 30% did not answer.

The respondents were also asked to evaluate the quality of restaurants and cafes, overall aspect of the town and how accessible it is by public transportation. The results were positive and most people evaluated the above mentioned as good, very good and a few even rated with an excellent. 25% did not answer when asked to evaluate how accessible is Yuantong town by public transportation. This could be due to the fact that according to the previous question that asked people to say how they arrived there, most than 80% said that they arrived by car. So, it would seem that very few actually used public transportation to get there, 2 persons to be more precise compared to the 46 who arrived by car.

Yuantong is destination that people knew of or found out about from the internet or friends and relatives. This suggests that the town is best promoted online and by word of mouth.

The local attractions received good reviews. More than 70% considered these to be Good, Very Good or Excellent even. Only around 10% rated with average and even fewer with poor. The attractions are: Catholic Church, Liu's Manor, Trading Hall (figure 24), Pagoda (figure 25) and Xeijiang River (figure 3 and 5) along with its old bridge (figure 4). These attractions were restored and during the period of the survey, Liu's Manor and the Trading Hall were open for visits. There were no activities happening on the river such as boat rides.

It resulted from the question that was asking the respondents what did they like the most that, overall, people were most satisfied with the atmosphere of the town including the streets and buildings, scenery and culture, environment, leisure life, the river and a few mentioned the food and river. 30% did not answer this question. Even more chose not to reply to what they disliked the most. Out of 59 persons, 43 gave no answer. Out of those that did, a few things

were mentioned like the parking, expensive tea, weather, no place to dabble in the water, too commercial, too small, toilets at the tourist center and the fact that transportation is not convenient. But most of these dislikes received just a single mention each. So, overall there were not many who had any complaints. Question 15 results are also good proof that most visitors in Yuantong town have they expectation met. Almost 80% declared this and only a little over 10% said otherwise.

Yuantong is a good weekend destination for those who live in the province of Sichuan, China who wish to trade the noise and agglomeration of the big cities with the quiet and relaxation a small ancient town like Yuantong can offer. Most of the local community considers that tourism is important for the long-term prosperity of their town and are saying that the quality of life has improved since more visitors started to show. And most of the visitors are happy with what Yuantong has to offer them and their families.

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