Food and Environment Safety - Journal of Faculty of Food Engineering, Ştefan cel Mare University – Suceava
Volume X, Issue 2 - 2011

THE EFFECT OF RURAL SETTLEMENTS ON WATER QUALITY IN NORTHERN SUCEAVA PLATEAU

***Andrei-Emil BRICIU[1], Dinu OPREA-GANCEVICI [1]**

[1]Stefan cel Mare University, Faculty of History and Geography, Department of Geography
e-mail: andreibriciu@atlas.usv.ro; dinuo@atlas.usv.ro
* Corresponding author
Received 2 May 2011, accepted 25 June 2011

Abstract: *The chemical analysis carried out in the summer of 2010 in the administrative area, built area-focused, of seven localities in northern Suceava Plateau indicate the existence of phosphates and nitrates pollution in the majority of sampling points, while nitrites are reduced in value and space and ammonium and sulphides are almost absent. The localities were chosen so that the geology, altitude, climate and hydrology of the areas should be as similar as possible, as neutral factors, in order to identify the causes of pollution. The sampling points were georeferenced and accurately marked on maps, where there are also the concrete values of measurements in order to be verified in the future monitoring of water quality. Phosphorus pollution is the highest and prevalent and it is caused by the lack of sewers and wastewater treatment. Some cities have an average water quality more deteriorated than others because of high population density and of the animal breeding in specialized farms. After identifying the main sources of concentrated pollution, a scenario of future evolution of the surface water and ground water quality is given, based on actual control factors. As the control factors and the neutral ones are similar for the entire northern Moldavian Plateau, the studied settlements can be considered representative of the mentioned area.*

Key words: pollution, phosphorus, sewage, drinking water, human pressure

1. Introduction

This paper has two objectives. The first objective is to use a representative sample of Suceava Plateau to discover the pollution level of surface water and groundwater caused by humans in the open and built space. The chosen areas are centred on the built areas of the following localities: Adancata, Berchisesti, Calafindesti, Fratautii Noi, Patrauti, Serbauti, Veresti (fig. 1).
The second objective is to create a correct and easily to re-use network of sampling points in the selected localities area in order to provide more accurate verifiability in the future of the evolution of used parameters. Field studies on water quality in Romania are based on sampling from wells of ANAR (Romanian Waters National Agency) and from points set by ANPM (National Environmental Protection Agency) or from other points, temporary and expeditionary selected and considered more representative and necessary.
In the first case, a basic criterion of science, that of the results' recurrence and of the verifiability, is applied to because the location of the sampling points is well known and always the same and the equipment used is standardized; in the second mentioned case, which occurs when the established points of ANAR and ANPM are not still considered sufficient, the repeatability of the sampling point is only

approximately respected, mostly using visual interpretable landmarks and not the GPS localization. Often, a slight spatial variation of the sampling point is considered, erroneously, insignificant. Important variations occur on small spaces due to intersections of the hydrographic network, variations of surface geology, vegetation type and density, slope of the land, springs, points of discharge etc. The insufficient knowledge of all these in detail prevents the correlation of the results taken from different points and, therefore, it is advisable to maintain the same sampling point.

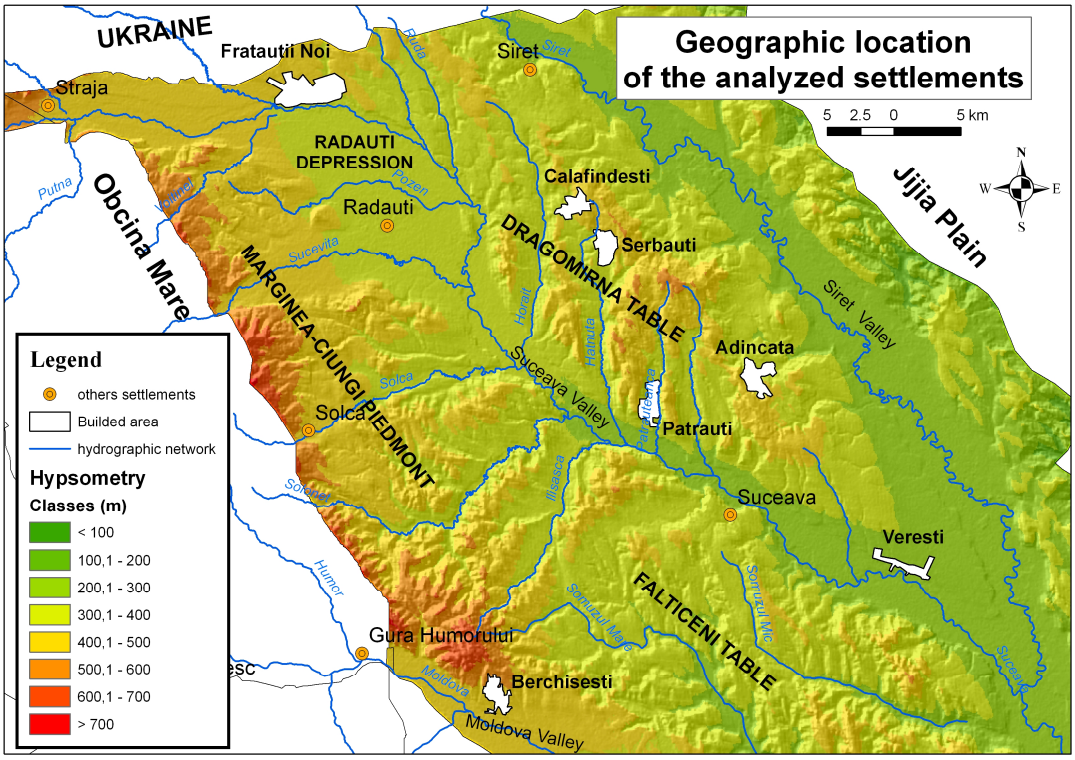

Fig. 1 – The location of studied settlements in the northern Suceava Plateau

2. Experimental and methods

The settlements were chosen in areas with similar rural landscape, a landscape represented by the subsistence agriculture mixed with the commercial agriculture respectively, both having a relatively well-developed animal breeding sector. Meanwhile, their average altitude does not vary greatly (the maximum difference is 200 m), which allows the existence of almost identical weather conditions; thus, the climate is a neutral factor which does not prevent the identification of the human effect on surface water and groundwater quality. However, there is a slight variation from west to east, thermally (from 7.5 to 8.5°C annual average) and pluvially (from 675 to 625 mm annual average), minor variations, as shown in the annual going of the synoptic conditions (precipitation of 180 to 160 mm in the cold semester and from 460 to 420 mm in the warm semester; temperatures from 14°C to 15.5°C in the warm semester and from 0.4°C to 0.8°C in the cold one). There is also a minor variation from NW to SE due to the elongation in this

direction of the Dragomirna Plateau and of the Suceava Valley.

Climate is an important aspect because it determines the rivers flow (and the dilution of certain pollutants), the groundwater supply and soil water loss by evaporation and evapo-transpiration. The geology of the area varies slightly, being represented by layers of gravel over homocline strata of alternating clays and sands, rarely sandstones and shales; the gravels create a certain morphology of the terrain represented by terraces, among which we mention the lower terraces, with high thickness, of Moldova and Suceava on which Berchisesti, Veresti and Fratautii Noi localities are placed. Inside the areas centred on the settlements, the points were equidistantly distributed so that they should be inside the built space and in the open field in order to capture the water quality difference between the 2 environments. For each area, there are 20 corresponding sampling points for nitrites, nitrates, total phosphorus and sulphur. Out of these 20 ones, only 15 were analyzed for ammonium. To keep the equidistance, the waters were taken from encountered sources, which are fountains and, rarely, springs.

A Hach-Lange DR2800 spectrophotometer was used to perform the analysis; the samples were analyzed within 24 hours of sampling in accordance with the methods developed by HACHDR2800 based on Standard Methods for the Examination of Water and Wastewater (20th ed.) [1] which served in other cases [2] at identifying pollutants in water in various environments. Water samples were taken in the absence of rainfall and the sampling points were georeferenced and marked precisely in ArcGIS maps using topographic maps made by DTM 1:25000 (Military Topographic Directorate) [3].

Vegetation and man are considered variables that explain the spatial distribution and levels of the pollutants.

3. Results and discussions

The test results show water pollution with nitrates and phosphates, as shown by studies in other extensively humanised areas of the globe [4-7]. Water samples showed that the analyzed water falls, on average, according to Romanian legislation, in the mediocre class for total phosphorus, in the medium class for nitrates and nitrites and in the very good class for ammonium, for sulphides it does not exceed CMA (Maximum Admissible Concentration) in all studied areas, excepting the following areas: Patrauti, in the mediocre class for nitrites; Veresti, in the mediocre class for nitrates and in the damaged one for nitrites; Fratautii Noi and Berchisesti - good class for nitrates (fig. 2-8).

Data from the studied settlements are similar to those obtained for nitrates by ICPA (Institute of Soil Science and Agrochemistry Research) from ANAR wells in neighbouring localities of Suceava Plateau in 2006-2007 when there were identified values up to 25 mg/l [8].

To identify the causes of pollution, we created a list of possible sources of concentrated pollution (composed of point sources and of small area sources) - former CAP's, stalls, areas with high density of housing, economic units, current and former landfills, deposits, communal land on which fertilizers were applied. The position of these sources was compared with the values of pollutants in the area and correlations of different intensities were found (Table 1).

Table 1
The correlation between 1. the identified pollution sources and 2. pollutant concentration and distribution

	Adancata	Berchişeşti	Calafindeşti	Frătăuţii Noi	Pătrăuţi	Şerbăuţi	Vereşti
Ammonium	**weak**	**weak**	**Weak**	**weak**	**weak**	**medium**	**medium**
Nitrites	**medium**	**medium**	**W ak**	**medium**	**medium**	**medium**	**strong**
Nitrates	**medium**	**medium**	**Weak**	**medium**	**strong**	**medium**	**strong**
Total Phosphorus	**strong**	**weak**	**Strong**	**strong**	**strong**	**strong**	**strong**

Phosphorus comes predominantly from point sources in these rural areas because of the sanitation lack and of deficient septic tanks, as shown by other studies in other rural areas [9-11], while the other pollutants come both from diffuse and concentrated sources.

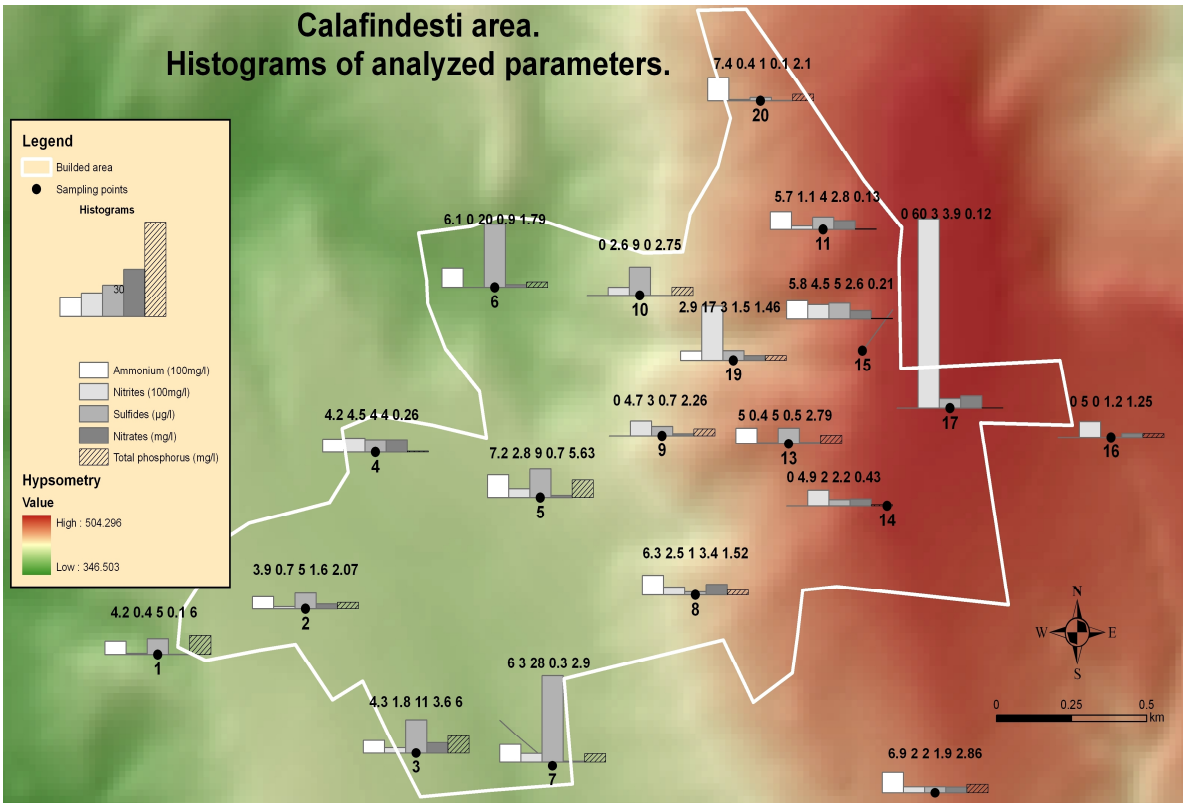

Figure 2. The values of the analyzed parameters and the sampling points in Calafindesti

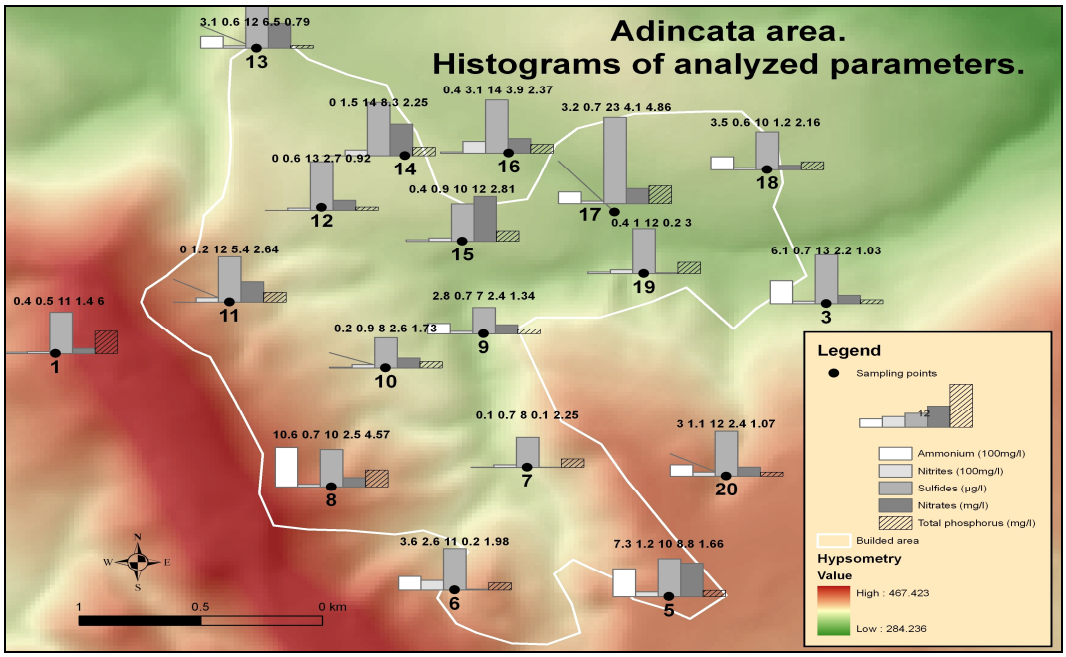

Figure 3. The values of the analyzed parameters and the sampling points in Adincata

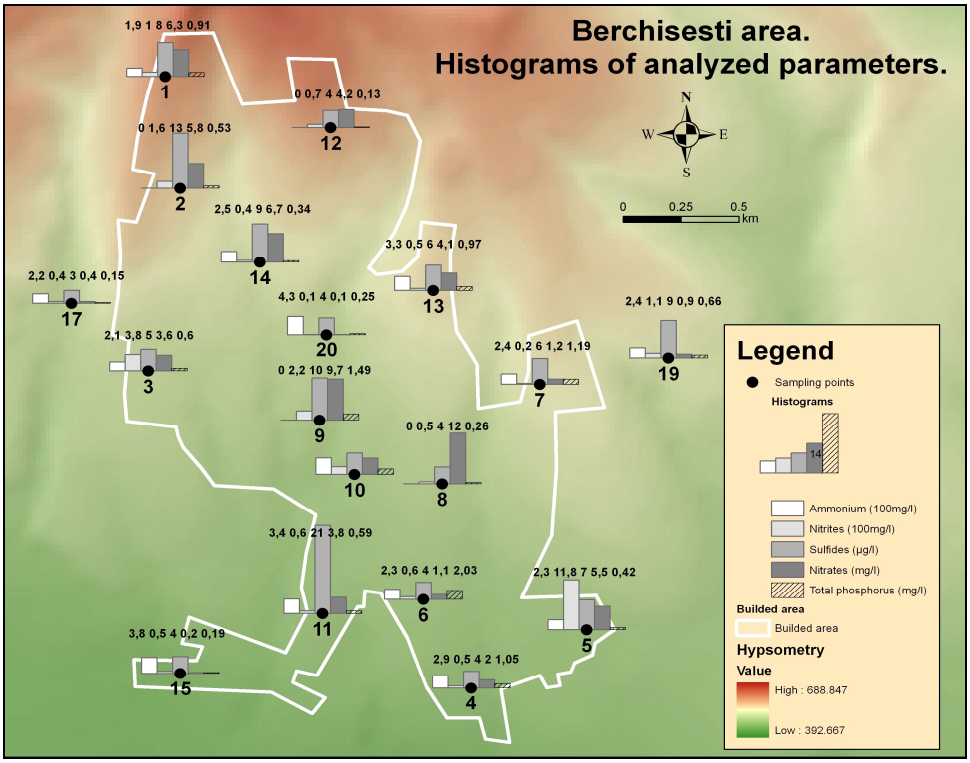

Figure 4. The values of the analyzed parameters and the sampling points in Berchisesti

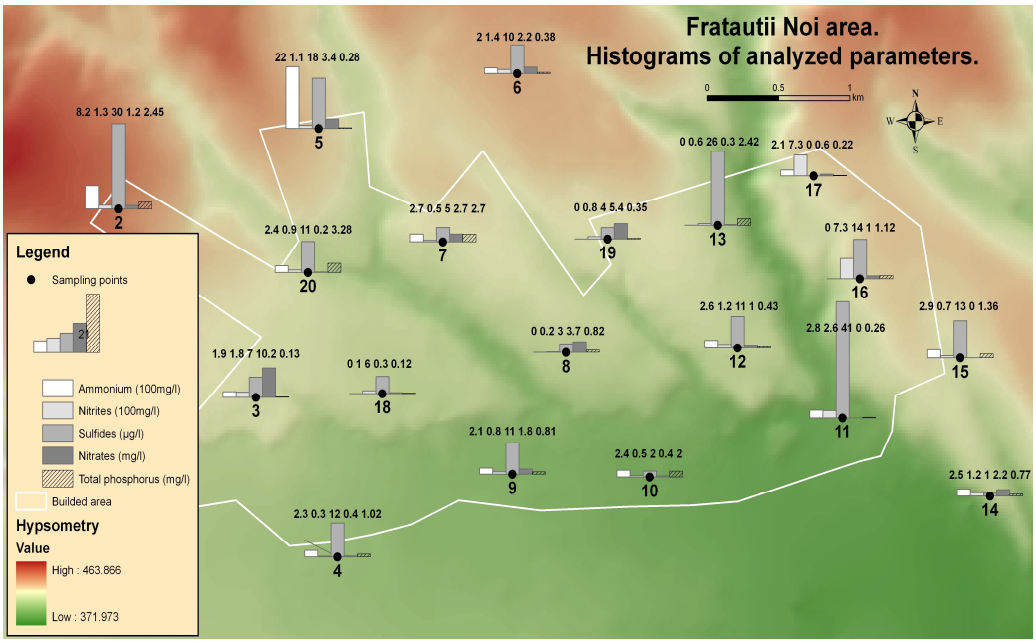

Figure 5. The values of the analyzed parameters and the sampling points in Fratautii Noi

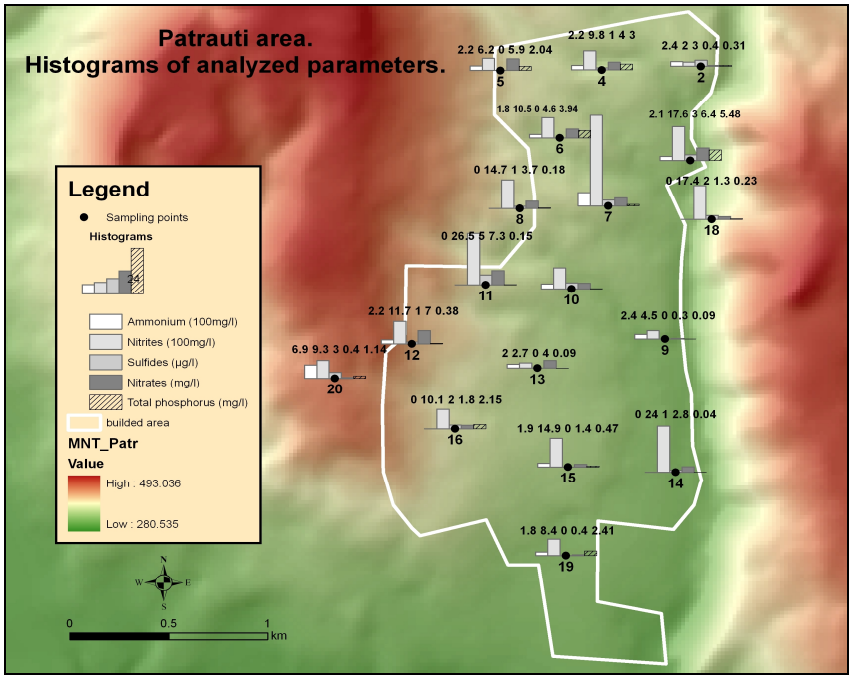

Figure 6. The values of the analyzed parameters and the sampling points in Patrauti

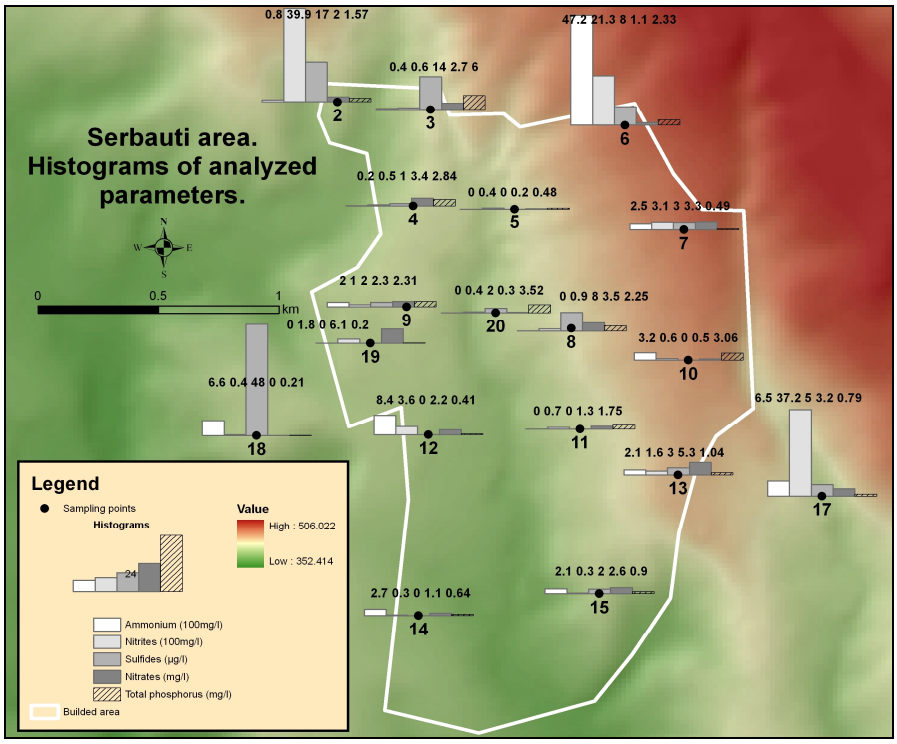

Figure 7. The values of the analyzed parameters and the sampling points in Serbauti

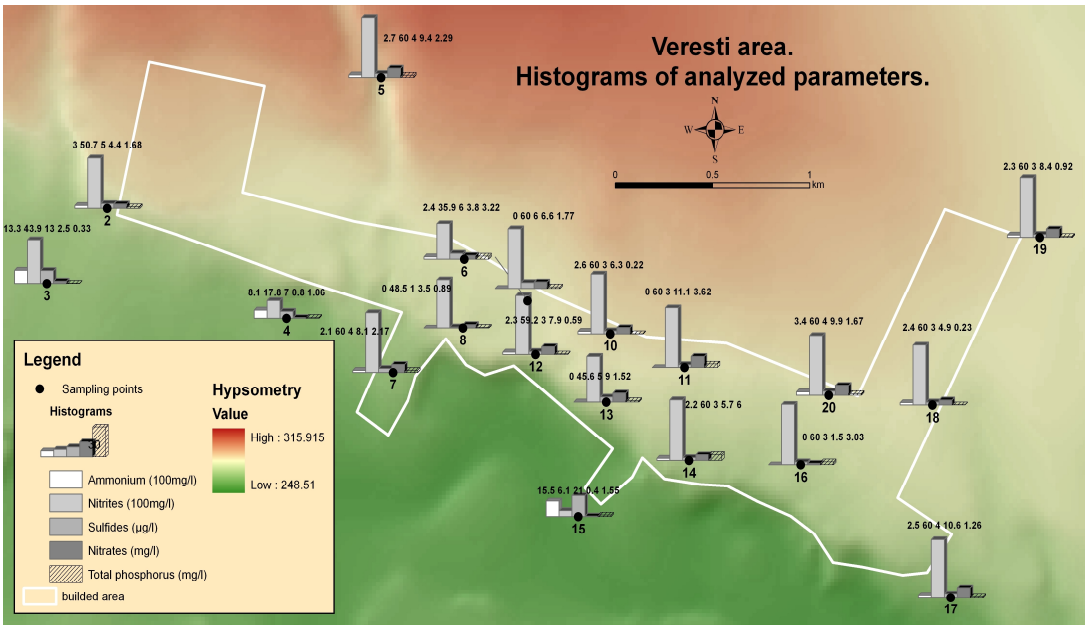

Figure 8. The values of the analyzed parameters and the sampling points in Veresti

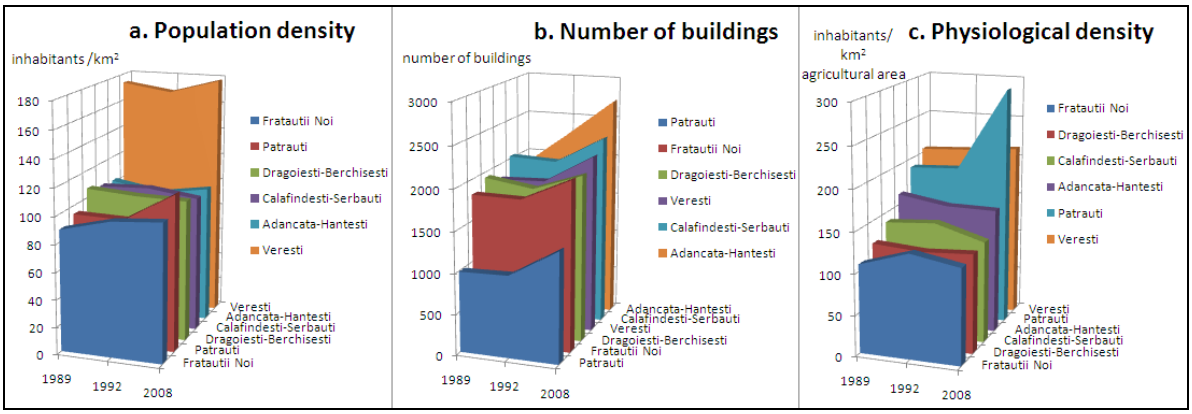

Figure 9. Control factors of the evolution of human pressure in the studied areas

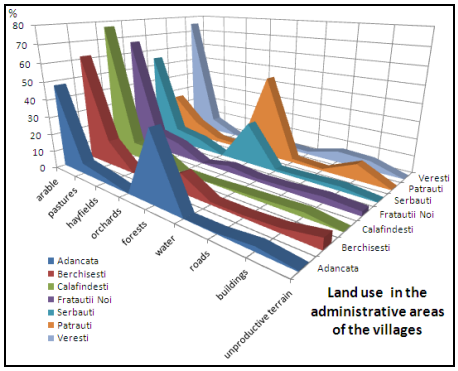

Figure 10. Land use in the administrative areas of the studied villages in 2008

We tried to find out if there is a correlation between population density of the studied areas and the pollution levels of waters, between the number of buildings and water pollution and between physiological density and water quality (villages were grouped into existing administrative units before the post 1989 reorganization in order to be comparable with data from 1989). We have observed (Fig. 9) that the very high population density and the physiological density in Veresti correspond to high pollution levels, especially with phosphate and not only. The highest physiological density is registered for Patrauti commune, which corresponds to high pollution in here. Figure 9 allows the extrapolation of current trends in the future and we can say with certainty that a major worsening of the present pollution, in the absence of countermeasures, will take place in the villages Veresti, Patrauti and Adincata, whereas the other studied areas will continue to degrade slowly their water quality.

There is a correlation between the land use and the level of water pollution. In Patrauti, Adincata and Serbauti, the forests occupy a large percentage of the administrative area and reduce the pressure that people could put on through agriculture (fig. 10); however, the percentage of Patrauti built surface is the largest of the villages analyzed, which affects, through concentrated pollution, the water quality - if the pollution had been diffuse, the environmental regeneration capacity would have been higher. Veresti has a high percentage of the arable and also of the built area, where large amounts of phosphates and of pollutants coming from chemical fertilizers were observed. Unproductive land consists mainly of ravines, landslides and very steep surfaces. These have the most important percentage in Berchisesti and were correlated with the high water quality in here.

4. Conclusions

The water of the areas studied is polluted in varying degrees. The pollution is made from point sources of pollution (especially with phosphorus) and shows a strong correlation

with high human density and size of the built area. As phosphorus pollution is the major problem identified and it is mainly due to the lack of sanitation, the introduction of an urban quality sewage system is an effective measure against pollution with phosphorus and nitrates. In the future, the monitoring of the seasonal evolution of the pollutants is needed, in order to identify the sensitive ecological months and to quantify the pollutants from agriculture (not used in winter) from those coming from other sources.

5. Acknowledgements

This work was supported by the the European Social Fund in Romania, under the responsibility of the Managing Authority for the Sectoral Operational Programme for Human Resources Development 2007-2013 [grant POSDRU/CPP 107/DMI 1.5/S/78342]".

Thanks for logistical support to Buhan Olivia, Cazacu Paul, Luchian Alexandru, Munteanu Adelina, Rîndaşu Diana, Saviuc Aleodor and Trotuş Bogdan.

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