Nutrient management at hydrographic basin level to avoid water pollution with nitrates from agricultural sources

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KEY WORDS

Pollution, nitrites, nitrates, hydrographic basin, Geru, organic manure management, eutrophication, fertilizer doses

SUMMARY

Nitrites and nitrates are the forms of inorganic nitrogen directly accessible to plants. They have an important role in plant and human nutrition, but they should not be overtaken, otherwise they become toxic. The presence of large amounts of nitrates in groundwater and their reduction has been debated since the middle of 20th century, but in Europe only in 1991 was adopted a Directive (91/676 / EEC) to prevent pollution of nitrate waters from agricultural sources, setting the alert threshold to 50 mg/l nitrate in water, while 100 mg/l classifies water as non-potable. In addition to setting a nitrate concentration threshold in drinking water, the Nitrates Directive mentions the importance of how to store manure from animal farms. After Chiriac and the contributors (1977), the most important feature of organic waste is the very high content of organic matter, generally very easily degradable. As a consequence, there is primary pollution by reducing the oxygen content in water. The secondary effect is the excessive increase of aquatic plants due to eutrophication. In order to avoid possible pollution of the waters with organic waste, it should be avoided to distribute them on river banks, on saturated or snow-covered soils, on large slopes. In Romania, the Nitrates Directive 91/676/EEC was transposed by Government Decision 964/2000, the inter-ministerial decision (Ministry of Agriculture and Rural Development and the Ministry of Environment, Water and Forests) of 11.10.2010, and then completed by Decision 221983-GC-12.06 .2013. Thus, in Galaţi County all communes were declared as vulnerable areas.

The basin of Geru river has a surface of 410.5 km^2 and is located in the central-southern part of Galati county, between 45°43'12" and 45°26'57" Northern latitude and 27°

37'50" and 27°47'32'' East longitude, beeing part of Siret basin. Geru river is the natural boundary between the Physical-Geographical Units of Covurlui Plain (in East) and Tecuci Plain (in West). It springs from Covurlui Hills and flows into Barladel river at 9 meters high, south of the village Piscu in Lower Siret Plain. Geology belongs to the platform unit, with a base of North Dobrogean origin, over which a sedimentary quilt was made up of mesozoic and neozoic deposits, as in the quaternary they were covered by loess and loessoid deposits. Loess is characteristic of peaks and slopes, colluvial deposits are found at the base of the slopes, and alluvial deposits in the meadows, which influence the soils developed in the area. The hydrography is constituted by Geru river and its tributaries, of which the most important are Gologanu and Vameş, and the underground water is found at depths of over 50 meters, on the interfluves and slopes, and between 0.5-3 meters in alluvial sediments. The climate is temperate-continental with excessive hues, with an average annual temperature of 10.4°C and an annual average rainfall of 485 mm. The vegetation is represented by steppe and silvo-steppe formations with predominant soils belonging to Chernozem, Phaeozems followed by Aluviosol, Erodic Antrosols and Gleysols classes, with medium textures and weak nitrogen and phosphorus supplies but good with potassium. Being a fairly accessible basin, since the 15th century the area has begun to be inhabited, and people have to deal with various agricultural activities, mainly plant cultivation and animal husbandry. Considering that at present all settlements have water supply without sewerage and in the twentieth century this area has been an intensive zootechnical activity, manure management is essential because it is a very important factor in groundwater pollution .

As far as this study is concerned, in Geru basin was made an analysis of the physical and chemical properties of soils and the determination of the chemical and organic fertilizers, the quantification of livestock at the commune and farms, the production of manure and nutrients from manure, the verification of certain parameters in the aquifer layer, in order to establish a connection that causes groundwater pollution.

This study is structured in twelve chapters as follows: 1. Introduction, 2. The global, national and regional framework that have conducted to the research, 3. Material and methods of research, 4. Edafic potential and ameliorative measures to increase the production and avoidance of nutrients pollution, 5. Production and management of organic manure in Geru basin,

Galati County, 6. Water quality in Geru basin, 7. Conclusions, 8. List of abbreviations, 9. List of figures, 10. List of tables, 11. Bibliography, 12. Annexes, and attempted to capture the triggers and potentiators of groundwater pollution with nutrients from agricultural sources.
The first chapter is a brief presentation of the subject and the objectives addressed.
The second chapter is structured in three subchapters, as follows: the legislative framework of the research, which presents the normative acts that are related to the topic approached and the manner in which they were implemented at the global, european and regional level, then the scientific framework of research with the presentation of the existence of nitrogen forms and its dynamics in the atmosphere, the presentation of the types of fertilizers (organic and mineral) and the analysis of the effects of nutrient pollution on vegetation (eutrophication) and the third subchapter presenting the physico-geographical and anthropogenic conditions in which the researches took place. In this subchapter were analysed the geological conditions and the paleogeographic evolution of the territory, the climatic conditions, the hydrological conditions, the geomorphological conditions with the description of the hypsometry and landscape decay, the types of tectonic-structural, sculptural and river accumulation relief and the degree of erosion of the soils, the vegetation of the area and the anthropic conditions with the presentation of the territory organization in Geru basin (the territorial administrative units Valea Marului, Cudalbi, Costache Negri and Piscu) and enumeration of the significant pressures on the water bodies.

The third chapter presents the steps, methods, materials and duration of the research. The preparation of this study was carried out in several successive stages, which in some cases interpenetrated. The first preliminary stage included documentation of the bibliographic material consisting of a series of papers dealing mainly with the soil, studied in relation to the whole complex of natural conditions (climate, relief, rock, vegetation, groundwater, age), agrochemical invoice works and environmental notions with special reference to nitrate pollution. To this is added the legislative documentation, which includes European directives, laws, orders, decisions, national and international, with direct action on the subject. The analysis was carried out both temporarily (2010, 2011, 2012, 2013) and spatial (on sectors of the upper, middle and lower basin).

The fourth chapter focused on the description and analysis of edaphic potential and ameliorative measures, including nine sub-chapters, such as: soil types and subtypes, soil texture, soil reaction, soil salinisation, humus soil supply, macronutrient soil supply, economic value of the lands in natural conditions, the limiting factors of agricultural production, soil requirements and measures, the elaboration of fertilization plans and optimal economic fertilizer doses.

In the fifth chapter the production of organic manure was quantified and their management was analyzed at the level of territorial administrative unit and farmers. This chapter has been structured into nine sub-chapters, such as the calculation of the big beef unit (UVM), the quantification of livestock in Geru basin, the quantification of annual manure production at the basin level, the yearly volume of the manure at the basin level, annual nitrogen production from manure, annual phosphorus production from manure, annual potassium production from manure, pressure induced by nitrogen per land unit, manure storage and proposed management measures for organic manure to avoid nitrate pollution from agricultural sources.

The highest water catchment value of the UVM was in 2010 (12829.99), declining greatly in 2011 (9488.86), in 2012 increasing again without exceeding the 2010 value (11939.07) and in 2013 the value per whole basin decreased slightly compared to the previous year (11083). Annual manure production was 127468 t higher in 2010, then declined to 102656 t in 2011, then rising to 116429 t in 2012 and then declining slightly in 2013 to 116219 t. Production of nitrogen from manure in 2010 was 890.5 t, in 2011 it was 638.89 t, in 2012 it was 816.82 t and in 2013 it was 811.04 t. The annual production of phosphorus from manure decreased from 228.17 t in 2010 to 139.87 t in 2011 and then increased to 170.76 tons in 2012 and 170.97 tons in 2013. Annual potassium production from manure also fell from 576.04 tons (2010), 431.29 tons (2011), 515.88 tons (2012) and 513.78 tons (2013). Thus, the pressure in kg/ha of total land was 3.82 (2010), 3.73 (2011), 3.27 (2012), 3.20 (2013), kg/ha agricultural land 4.01 (2010), 3.91 (2011), 3.43 (2012) 3.36 (2013), the pressure kg/ha of arable land 4.47 (2010), 4.36 (2011), 3.82 (2012), 3.75 (2013), 5.86 (2013).

The sixth chapter presented and analyzed the quality of the water in the basin of Geru stream. Structured in two subchapters, it focused on the identification of underground water

bodies in Geru stream basin and on the monitoring and characterization of the water state in Geru basin, the indicators being analyzed: water temperature, water conductivity, water oxidability, nitrite content in water, nitrate content from water, conditionality of nitrite/nitrate ratio in water, water reaction, chlorophyll content in water, groundwater level.

Nitrates in the water ranged between very low and very high values, with large values being found in the localities. Thus, in July 2012 out of 59 points 28 showed values below the maximum, in July 2013 out of 77 points, 21 had optimal values, and in November 2013 out of 71 points only 19 showed below-limit values. Conditionality was met in July 2012 at 9 points, in July 2013 at 19 points and in November 2013 at 18 points. Nitrites being a very unstable form of nitrogen, when reading in July 2012 at all points this parameter exceeded the maximum value. At the July 2013 reading, out of 77 points, 67 had values below the maximum, and in November 2013 60 points were below the limit. For the fertilization of soils in Geru basin with organic fertilizers 1307992 t of manure is needed. Compared with manure production, it can be noticed that at basin level it can be supplemented with livestock, manure may be imported, but public authorities have to implement manure management programs at the communal level, as well as educating the population about the dangers of manure mismanagement.

The seventh chapter summarizes the findings of the research. Considering the increasing concentration of nitrates and nitrites in groundwater, although livestock has decreased and the amount of organic fertilizer applied on agricultural land does not exceed 170 kg/ha (nitrogen), this leads to the idea that pollution water is due to the mismanagement of manure, its storage in the field and on the banks of the water and its administration on agricultural land without regarding to the application timetable, often being introduced into the soil when there is no vegetation to consume the nutrients facilitating the infiltration of nitrogen and phosphorus into the groundwater, plus the management of potable water supply networks built without a sewerage and wastewater treatment system. The results and recommendations made in this study will be made available to city halls to be included in the Local Action Programs, with a view to adopting optimal measures to eliminate potential pollutants in the watercourse of Geru river basin.