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STUDIES AND RESEARCHES REGARDING THE PROCESS OF CLOGGING OF DRAINAGE PIPES, WITH FERRUGINOUS SEDIMENTS IN DRAINAGE SYSTEM SANNICOLAU MARE – SARAVALE, TIMIS COUNTY

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Abstract. *Drainage has, over time, become a highly diversified tool. While a few decades ago it was focused almost exclusively on removing excess water, modern drainage has become part of integrated water management, removing or conserving the necessary volumes of water and also addressing water quality and environmental values. The operating process of drainage pipes consists of absorbing and then removing excess moisture from the soil profile, especially from the area near the plant root system. The clogging of drainage pipes with mineral deposits—particularly mineral deposits of iron and manganese compounds—is one of the most widespread causes of the malfunction of an absorbent drainage network. Also, to improve soil quality, humans can intervene through various pedo-hydrological or agro-phyto-technical measures such as fertilisation, irrigation, drainage, terracing, embankment, deep ploughing, etc. Soil reaction is corrected using amendments—calcium for acidic soils and gypsum for alkaline soils. It is important to maintain the humus content of the soil through the incorporation of organic matter, as humus also plays a significant ecological role by reducing environmental pollution with xenobiotic substances. The improvement of soils with excess moisture includes a set of hydro-improvement methods (drainage, land reclamation, embankment) and agro-pedological measures (deep loosening, levelling, land shaping, drainage). The complexity of the process, along with the insufficient study of the formation of ferruginous deposits, has led the authors to investigate the nature of their formation in order to establish methods for preventing and combating the clogging of drainage pipes.*

Keywords*: soil, excess moisture, drainage, sediments, agriculture*

INTRODUCTION

The commune of Saravale is located in the Mureș Floodplain, the youngest landform characterized by relatively narrow widths ranging from a few tens to a few hundreds of meters. It presents a series of features represented by levees with depressed areas, abandoned valleys, and weakly faded forms, even though part of the floodplain has currently been protected from flooding through embankment works.

The low plain of the Aranca River displays a range of characteristics generated by very strong meandering, the abandonment of riverbeds, and the creation of new channels with fresh sediment deposits. The diversity of landforms (alternation of levees, oxbow lakes, flood channels, mounds, micro-depressions, scattered with erosion remnants from the old plain formed on loess-like materials) is greater along the paths of former valleys.

The main collector of the Aranca Plain is the Aranca River, established on former channels of the Mureș River, and it had a vast area of river wandering before embankment. The temperate-continental climate is moderate, with shorter and milder winters, frequently under the influence of Mediterranean and Atlantic air masses. The multiannual average temperature is 10.7°C (Sannicolau Mare station).

The average annual precipitation value of 536.3 mm, recorded over the last hundred years, generally ensures a positive water balance in the soil during spring, the period of maximum consumption for various crops.

The vegetation specific to the area is silvosteppe formation transitioning toward semi-humid steppe, thus typical of a low plain, with moist areas dominated by herbaceous vegetation, while woody vegetation is represented by isolated specimens or small clusters.

Due to its location, the natural conditions are specific to a subsidence and river-diversion plain, where the main soil types have formed and evolved, represented by chernozems, vertisols, alluvial soils, solonetz, and gleysols. These reflect their geobiochemical properties and various morphological associations, expressed through land evaluation scores (bonitation), based on which lands have been classified into quality classes—defining characteristics that determine the growth and productivity of major crops (TARAU, ROGOBETE and NITA, 2019).

The low plain of the Aranca, where the very gentle slope of the terrain has led to intense meandering of water flows, the abandonment of riverbeds, and the formation of new channels with fresh sedimentation. The variety of landforms (alternation of levees, oxbow lakes, flood channels, mounds, microdepressions, scattered with erosion remnants from the old plain formed on loess-like materials) is more pronounced along the former valley courses, later reshaped by wind action. The Galatca Plain (Pesac–Lovrin–Tomnatic–Teremia), aligned along an old Mureș levee and the main course of the Galațca River, with altitudes around 100 m, is mostly formed of coarse fluvial deposits.

The main collector of the Aranca Plain is the Aranca River, which flows into the Tisa River. The Aranca Canal is established on former channels of the Mureș River and had a wandering area before embankment.

To improve soil quality, humans can intervene through various pedo-hydrological or agro-phytotechnical measures such as fertilisation, irrigation, drainage, terracing, embankment, deep ploughing, etc. Soil reaction is corrected using amendments—calcium for acidic soils and gypsum for alkaline soils. It is important to maintain the humus content of the soil through the incorporation of organic matter, as humus also plays a significant ecological role by reducing environmental pollution with xenobiotic substances.

The set of anti-erosion measures that must be applied to soils affected by this process includes, as an important component, land organization, watercourse regulation, slope management, crop structure, crop rotation, fertilizer application, soil tillage, anti-erosion farming systems (grassing, strip cropping), and afforestation.

The improvement of soils with excess moisture includes a set of hydro-improvement methods (drainage, land reclamation, embankment) and agro-pedological measures (deep loosening, levelling, land shaping, drainage).

The underground drainage is the most efficient method of draining the agricultural grounds with excess humidity.

One of the basic conditions that the drainage systems must fulfil is the security of exploitation. In this way, these systems must provide the projected hydria condition for the agricultural grounds for 20 – 50 years of functioning.

The most frequent cause of the deterioration of the drainage network is the clogging of the draining pipes with sediments of silt and sand, as well as ferruginous sediments in the

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drainage pipes from underground waters. At some drainage systems the ferruginous sediments are more dangerous than the usual clogging with usual sediments (fine sand or silt).

A similar situation can be found in the frame of underground and opened drainage system in area Sannicolau Mare – Saravale, Timis County.

This system was made in two steps:

- the first step time was made in 1958 – 1960 and the made area it was served by the pumping station Cenad.

- the second step was made in 1982 – 1986 and the made area it was served by the pumping station Mures.

Few years after the finish of the first step, the researches made on some drainage pipes of the drainage system showed that circa 60 – 70 % of the drainage pipes are useless, the principal cause of this regretted situation being the clogging of the drainage pipes with ferruginous sediments and also a silting of this drainage system (with fine sand and silt) .

These establishments were made with the opportunity of digging some foundations pits in our area arranged with draining pipes, when a lot of draining absorbent nets made by ceramics was touched

Because of the complexity and the insufficient research of the process in which is forming the ferruginous sediments, determined some experts (HALGREN and WIKLANDER, 1986) to affirm that finding an universal method for preventing the forming of the sediments in the drainage systems is very a difficult problem, therefore there are necessary some researches both form quantitative and qualitative point of view which come very close to the phenomenon that is happening in the drains, in order to assure in the future a normal rate of functionality.

MATERIAL AND METHODS

The ferruginous sediments from the digging drains having the source in Sânnicolau-Saravale, were represented by a gluey and loose paste, sometimes with solid acicular or lamellate concretions having a brown–red colour or sometimes even brown–black colour.

The drains sediments are characterized by a complex chemical composition in which prevail the following chemical compounds: Fe_2O_3 : 69 – 76 % ; Al_2O_3 and Mn_2O_3 : 7.2 – 8.2 % ; CaO : 4.2 – 4.5 % ; P_2O_3 : 1.1 – 1.4 % ; MgO – 1.2 % and some other chemical compounds in smaller percent.

The specific weight of the compact sediment was 2.55 g / cm^3, which means that the mentioned weight is near to the specific weight of sand.

The iron compounds are the result of the chemical reactions and of the biological activities of the ferric bacterium. The participation of those mentioned before to the clogging of the draining pipes even though it is certain, practically it isn't established, the expert's opinions on this fact being diverging. The iron, which migrates in the composition of the triad (Al^{+3}, Fe^{+3}, Mn^{+2}), is entering in the draining pipes together with underground waters. The percent of iron in these compounds, which is accumulated during the process of soil proceeding, is represented by the following horizons: *argillaceous sands* (1,5 – 2,5 %), *heavy argillaceous sands* (5 – 7 %), *gleyed horizon* (32 – 74 %) (SVOBODODOVA,1986).

The iron content is suddenly growing up in water in case in soil is present an organic substance (peat and humus) which activates in water the process of the chemical reduction, having as a result the forming of the carbon dioxide. The more the soil remains under the influence of excess humidity, the more underground formatted waters contain carbon dioxide, which will involve more iron compounds in water composition. Thus, the clogging danger is increasing.

In underground waters, the iron is found as a protoxide (iron dioxide Fe $(HCO_3)_2$), as well like complex organic compounds, formed by humus acid.

When the underground water is entering the draining pipes, the iron dissolved in this water create a chemical reaction with the oxygen from the drainage pipes air, and the iron protoxide becomes an oxide which is clogging the draining pipes. The expert's opinions concerning the quantitative criteria of clogging the draining pipes with ferruginous sediments are different. Thus, the authors' observations about sectors with an iron content soil, higher than 3 – 8 mg / l, are that in the draining pipes appear obturators which might compromise the entire draining line, after three or four years from the execution of the drainage system.

RESULTS AND DISCUSSIONS

According to the authors for the draining pipes made by plastic materials, the up limit concentration is 3 mg / l, in underground ferruginous waters.

The German normative regarding the materials used for drainage and the execution of drainage systems, says that the danger of clogging in case of the presence of ferruginous underground waters appears when the iron content is between 3,2 – 6,3 mg / l, or the content of iron oxide is higher than 8 mg / l.

In MURASCO'S (1972) opinion, the elements of the ore triad are beginning to sediment at the following values of pH: aluminium – 4,2; iron – 5,5; manganese 7,5 – 8,5. The clogging of the draining pipes with ferruginous sediments starts in usual conditions at pH < 5,5 values.

The experimental lab of Bremen suggests the following approximated criteria for the determination of the necessity for ceramic pipe protection against clogging with ferruginous sediments (see the following table).

Table 1

Approximated criteria for the determination of the ceramic pipes protection

The administration necessity of prophylactic measures for draining pipes supporting against the ferruginous sediments	The iron content in underground waters in mg / l		pH
	Limits	Medium values	
The protection is not necessary (No requested protection)	0,3 – 0,7	0,5	3,5 – 5,5
It's necessary a low – medium protection (requested a low – medium protection)	0,2 – 33,5	5,4	4,7 – 7,4
It's necessary a medium – high protection (requested a medium – high protection)	1,8 – 19,3	8,7	3,6 – 6,1
Absolutely necessary a high protection (requested a high protection)	2,1 – 58,5	13,8	4,3 – 7,8

Beside the iron compounds content and the oxygen content from draining pipes, the forming of the ferruginous sediments is influenced by the presence of humus and silicon acid in underground waters (HRUTKAIA,1970).

The iron hydroxide formed in draining pipes is reacting with the smaller quantities founded in compounds of phosphorus, manganese and other elements, and certainly with small particles of silt and sand which are entering in draining pipes, the final result being a gleical rennet which could obdurate the entire flowing section of the draining pipes.

The iron hydroxide is also partially lying down on the soil around the draining pipes, on the pores of filters, on the perforations of orifices and especially on the internal surface of the pipes.

CONCLUSIONS

The researches about the way in which the mineral sediments have been formed, made the authors to establish the main causes of the drainage networks clogging. The good knowledge about the forming and the sedimentation of the iron and manganese compounds on the drainage pipes, especially ceramic, put the authors in the position to propose more prophylactic ways for preventing and fighting against the drainage pipes clogging with ferruginous and manganese sediments.

Research into the processes by which mineral sediments form has enabled specialists to better understand the primary mechanisms responsible for the clogging of drainage networks. These sediments, particularly those rich in iron and manganese, originate through a combination of chemical, biological, and physical processes that occur in the soil–water environment surrounding drainage systems.

Iron and manganese are naturally present in many soils and groundwater sources, typically in dissolved forms under reducing (low-oxygen) conditions. When groundwater flows through drainage pipes, especially ceramic ones that often have porous surfaces and micro-irregularities it comes into contact with oxygen. This change in environmental conditions triggers oxidation reactions, transforming soluble iron (Fe^{2+}) and manganese (Mn^{2+}) into insoluble oxides and hydroxides. These compounds then precipitate and gradually accumulate on the inner walls of the pipes.

In addition to purely chemical reactions, biological activity plays a significant role. Iron-oxidizing and manganese-oxidizing bacteria can accelerate the precipitation process by catalyzing oxidation reactions. These microorganisms form biofilms that trap and bind mineral particles, further contributing to sediment buildup. Over time, these deposits harden and reduce the effective diameter of the pipes, eventually leading to partial or complete clogging.

The structure and material of the drainage pipes influence the rate and extent of clogging. Ceramic pipes, for instance, tend to be more susceptible due to their rougher internal surfaces and higher permeability compared to modern plastic alternatives. These characteristics favor both the adhesion of precipitates and the development of microbial colonies.

A thorough understanding of these formation and deposition processes has allowed researchers to propose several preventive (prophylactic) and remedial measures. Preventive strategies include improving drainage design to ensure consistent water flow, minimizing stagnant conditions that favor sedimentation, and using materials less prone to encrustation, such as smooth plastic pipes. Additionally, filtering systems or geotextiles can be installed to reduce the entry of iron-rich particles into the drainage network.

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