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SOIL IRRIGATION WITH WASTEWATER IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

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Key words: nitrogen, effluent, irrigation, soil, wastewater, nitrification

Abstract: An important element of analysis from climate change is the water balance. Soil water has a tendency to decrease due to temperature increase. It affects violent relatively large areas of land on long term, causing damage and environmental degradation through soil destruction, decreased agricultural production, vineyards and livestock, reducing the nutritional status of the population. Soil hydric deficit is the most important risk factor in agriculture. Through irrigation, soil moisture is maintained in critical phenophases between the minimal and water field capacity. Irrigation work is the only way to adjust the water flow in soil using water of specially designed accumulation, where that is possible or through abstraction from watercourses. Saving resources in the current context of climate change and of economic globalization is only possible through a sustainable development. To fit in sustainable development, the agriculture will require technologies and new equipment for more efficient recovery of irrigation water, it will use more unconventional water resources and it will comply the quality management requirements. In this context, the authors analyze the possibility of capitalization of properly treated wastewater to be considered good water for irrigation.

Introduction

Climate changes influence all economic sectors but the most vulnerable is agriculture, by water level reducing, important phenomenon that shows reduction tendency in the soil due to increased temperature, called drought. The water scarcity directly affects many systems and sectors essential to human existence as water resources, food security and health. Saving resources in the current context of climate changes and economic globalization is only possible through a sustainable development, saving the environment. Sustainable development sustainable development, viable and economically sustainable, is considered that development that satisfies present's needs without compromising the ability of future generations to meet their own needs.

Romania's accession to the European Union involves an changes

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implementation, especially in agriculture, leading to an sustainable development and performance (Dima, 2004). To fit in sustainable development, the agriculture will require technologies and new equipment for more efficient recovery of irrigation water, it will use more unconventional water resources and it will comply the quality management requirements (Alecu, 2007). According to experts estimates, about 2% of the total agricultural area of Romania, about 15 million hectares are affected annually by extremely severe drought, crop production is impossible without irrigation, while on 38% of agricultural area irrigation is used to supplement rainfall to ensure the necessary moisture (Eurostat). According to data presented by the National Agency of Land Improvements in recent years the irrigated areas have increased significantly. (fig. 1)

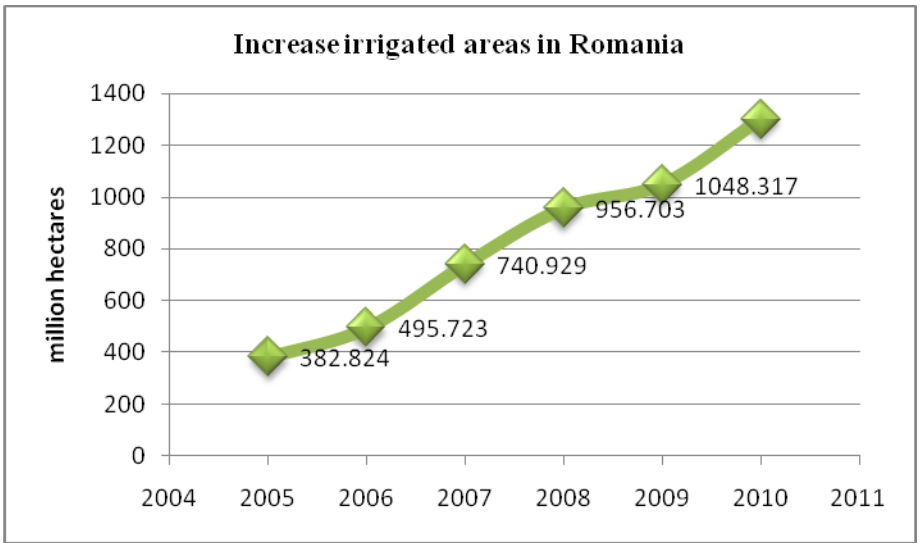

Fig. 1 - The irrigated areas increase in Romania

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1.The need to use the effluent in culture irrigation.

Drought is a dangerous weather phenomenon resulting from temperature increase which has a long installation, is characterized by rainfall decreased below average and excessive drought appearance (Dima, 2004). This violence affects relatively large areas of land on long term, causing casualties, property damage and environmental degradation through soil destruction, decreased agricultural production, vineyards and livestock, increased inflation, reduced nutritional status of population, diseases, and crisis energy by lowering the river water flows, which will reduce the production of hydroelectric energy.

Tab. 1 - Climate changes impact on soil and vegetation.

Climate changes impact on		
soil	directly	results due to temperature increase, the volume and intensity of precipitation and carbon dioxide concentration
	indirectly	due to modifications that climate changes bring to the vegetal cover or to the soil biota.
vegetation	• increased soil erosion and the washing fluid /leachate nutrients (surface water, groundwater respectively) due to changes in volume and intensity of rainfall; • changes in soil structure and texture due to increased tendency of weathering / alteration under the excessive climate influence; • wind erosion enhancing due to higher summer temperatures and reduced rainfall in summer; • reducing the quantity and quality of soil organic matter due to reduced photosynthesis in plants and concomitant reduction rizodeposits; • soil biota biodiversity loss due to increased temperature and reduced water content; • salinization of soils due to increased evaporation processes.	

An important element of analysis from climate change is the water balance. Soil water has a tendency to decrease due to temperature increase. The effects of water scarcity directly affects many systems and sectors essential to human existence as water resources, food security and health. Phenomenon is typical of many areas of the world located in the tropical latitudes and temperate. Through irrigation, soil moisture is maintained in critical phenophases between the minimal and water field capacity. Hydric soil deficit is the most important risk factor in agriculture. Irrigation work is the only way to adjust the water flow in soil using water from specially designed accumulation, where that is possible or by abstraction of water courses.

Adopting the solution with water transfer from a river basin to another involves high costs, so a cheaper alternative is the recovery of wastewater directly discharged into rivers from large urban agglomerations. Thus considering the possibility of a properly treated wastewater to be considered good water irrigation.

The main pollutants from wastewater are organic pollutants who in the presence of heat come in fermentation and affects surface water and groundwater by infiltration into the soil, also soil and vegetation (fig. 2).

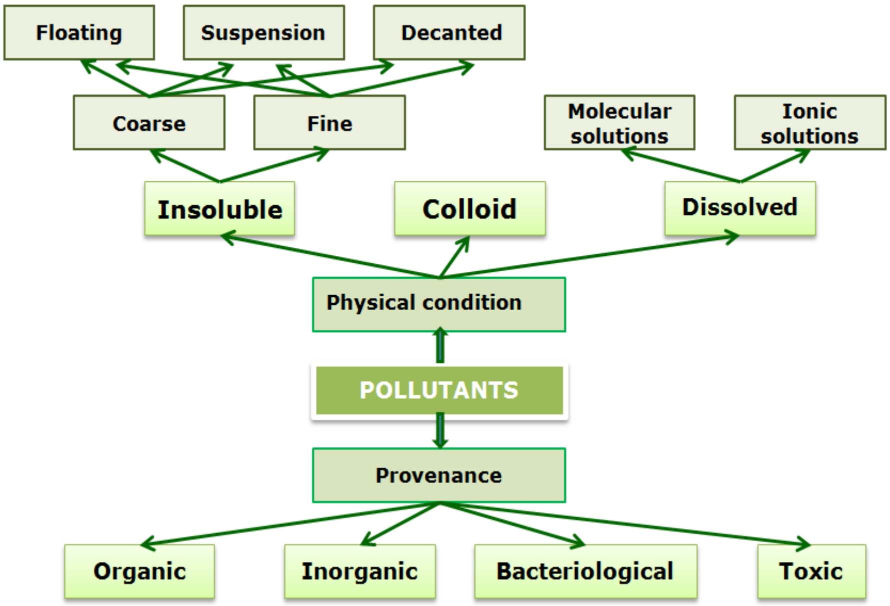


Fig. 2 - Pollutants from wastewater

Nitrogen concentration in the wastewater entering the treatment plant is 90% and is in the form of ammonium ions or organic compounds unstable, later transformed into ammonium ions. Total nitrogen in wastewater can be found as free ammonia (60%), organic nitrogen (35%) and salts of nitrite and nitrate (5%). Organic nitrogen (proteins, amines, amino acids) quickly turns into ammonia and ammonia compounds. The resulting effluent by classical biological step is residual nitrogen in various forms, predominantly nitrate that reached receptor stimulates eutrophication.

Phosphorus and nitrogen compounds are easy assimilated by the algae, contributing directly to increased the eutrophication rate of stagnant or the slow flow water. Classical procedures of wastewater treatment does not ensure the elimination of excess fertilizer compounds, nitrogen, phosphorus and potassium, those presenting a removal efficiency of 50% nitrogen and 40% phosphorus. Conventional wastewater treatment presents an efficiency of 15-40% in terms of total nitrogen removal and 10-30% in total phosphorus removal.

Recent research highlighted in the specialized literature shows that in treatment plant eguipped mechanical and biological, the efficiency of total nitrogen removal of 5-25% and of 10-30% in total phosphorus removal, so a big part of the nitrogen and phosphorus compounds get in the receptors with negative consequences on the environment (Dima, 2005).

In figure no 3. and no. 4. is presented the efficiency of remove the N and P concentrations from the effluent in the first stage of treatment.

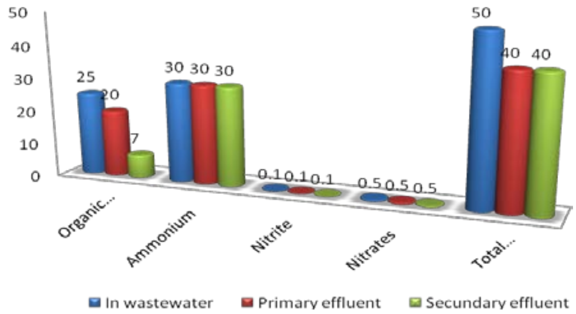


Fig. 3 - Concentrations of nitrogen compounds removal efficiency [mg/dm^3]

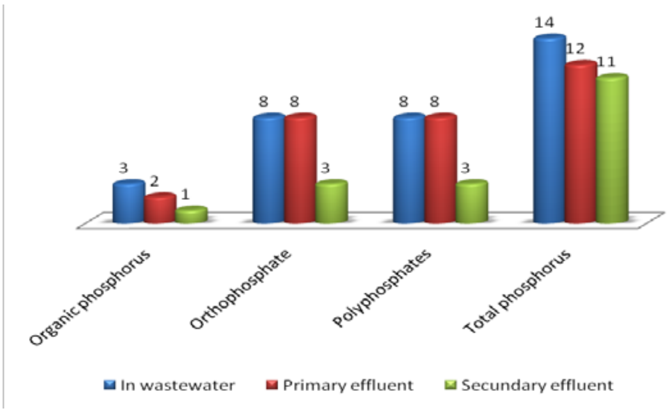


Fig. 4 - Concentrations of phosphorus compounds removal efficiency [mg/dm^3]

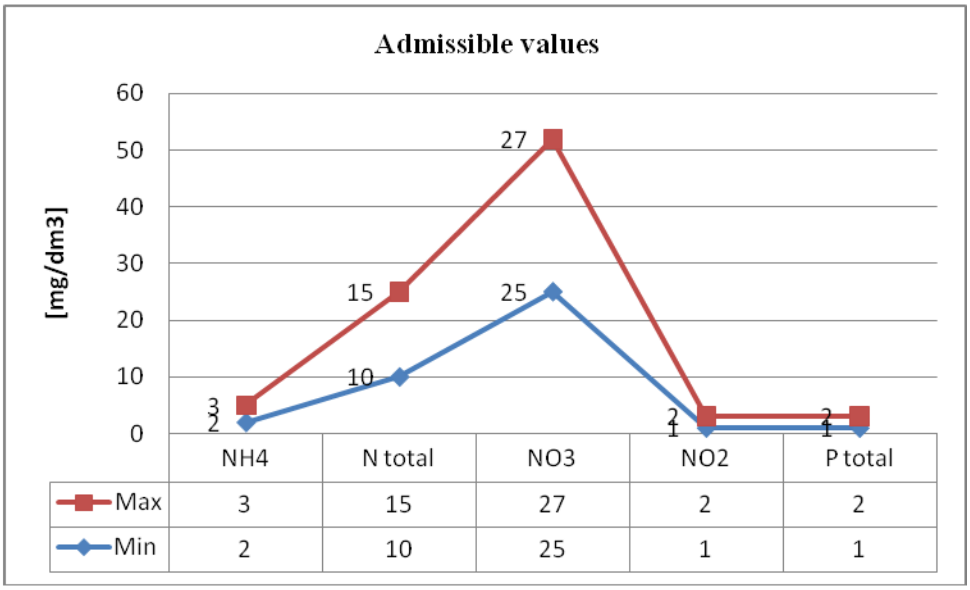


Fig. 5 - The maximum and minimum allowable compounds of nitrogen and phosphorus leaving the station

Where quantities exceed their allowable limits in wastewater pose a negative impact on the environment, becoming aggressive pollutants to groundwater, surface water, soil and air.

Tab. 2 - Influence of nitrogen and phosphorus on soil quality and water

Influence of nitrogen and phosphorus on soil quality and water
• iodized ammonia is toxic to aquatic fauna • decreasing dissolved oxygen in waters Envoy • increasing the concentration of nitrate in waters Envoy • increased eutrophication rate

2.Need to implement a tertiary step in wastewater treatment

In the absence of water for irrigation, the solution for capitalize treated wastewater in agriculture can be taken as an alternative to help reduce stress water. Wastewater use shows a special importance regarding the improve of structure and water permeability, with positive effects on the quality of agricultural works, adjustement of hydric regime, intensification of microbial life with improved effects on polluting phenomena and with a biostimulation role for all the processes that happen in soil.

The condition to apply the solution of wastewater irrigation is to adapt the technological processes in order to eliminate the dangerous factors to health (microorganisms, bacteria, viruses, heavy metals) to fit in the relevant legislation. Among these wastewater purification solutions, the most commonly applied is the advanved treatment (tertiary stage).

Tertiary stage (advanced treatment) and 3rd stage of treatment does not exist at all treatment plants, it is a new technology of retaining from wastewater the fertilizer compounds (nutrients: nitrogen and phosphorus) and other contaminants with chemical and biological structure which does not allow them to be detained and removed in a typical treatment plant. Applied technologies are based on physico-chemical processes (chemical coagulation, adsorption) and biological (nitrification, denitrification).

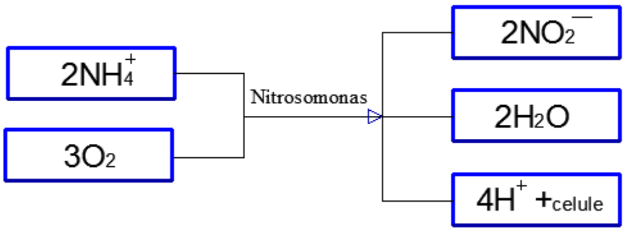
Tertiary treatment or advanced treatment of wastewater follows the removal from wastewater of refractory substances like treated water, in current context of water crisis, can be reused, even for drinking, and impurities to be completely destroyed not to affect natural water quality.

3.Advanced methods of treatment

Nitrification process - the process by which ammonia is oxidized sequentially to nitrite (NO2-) and then to nitrate ($NO3^-$), in a well oxygenated.

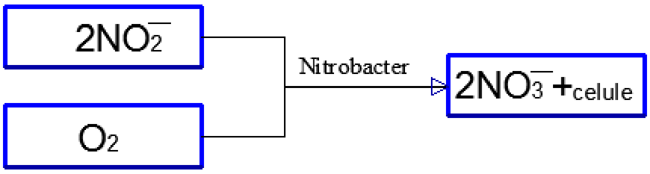
It is a process whose biological reactions take place in two stages and uses nitrifying bacteria as Nitrosomonas and Nitrobacter (autotrophic organisms) for cell growth and maintenance.

The first step is the oxidation of ammonium to nitrite ion, according to reaction:



At this stage, when ammonia concentration is high compared to the need of organic matter decomposition (BOD) hydrogen ions released in the oxidation of ammonium to nitrite lower pH. So it will adjust pH by adding alkali. Uncorrected, it leads to reducing or stopping the process of activated sludge biological treatment.

The second step is the oxidation of nitrite (nitrite) to nitrate, according to reaction:



In the process of nitrification for ammonia oxidation to nitrogen is necessary a large amount of oxygen, 4.5 kg per 1 kg ammonium nitrogen (NH_4-N) oxidized

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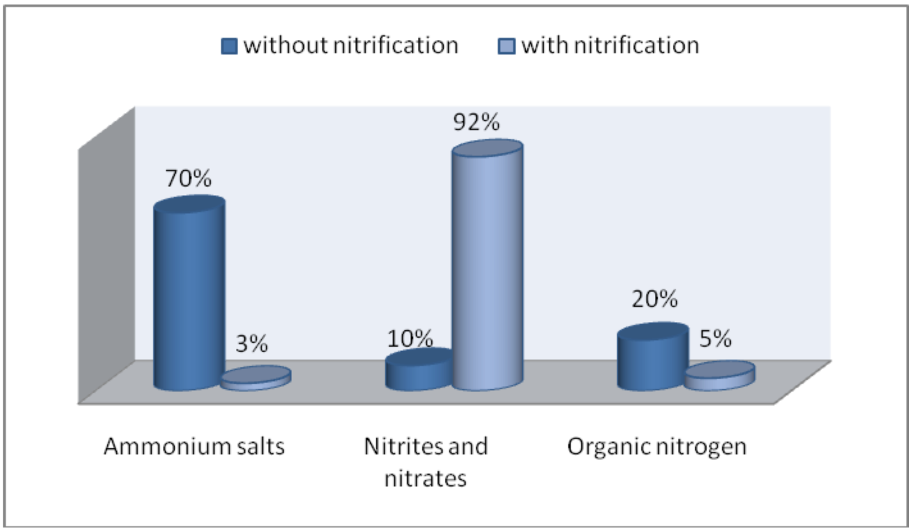
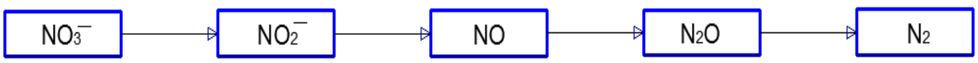


Fig. 5 - Reduction of nitrogen compounds from wastewater with and without nitrification

Denitrification process - is the progressive reduction of nitrogen to form molecular nitrogen, using an oxygen free environment under the action of denitrification bacteria (Pseudomonas, Achromobacterium), denitrification continues the process of nitrification for nitrogen forms removal.

Denitrification process takes place according to reaction:



Denitrifying bacteria transition from aerobic to the anaerobic environment is followed by repression of enzyme denitrifying synthesis. Reduction of NO_3^- - N is based on two types of enzymatic systems: treated and dezasimilante. In the first trial - NO_3 - N is converted to ammonia nitrogen for use by cells in the biosynthesis and occurs when NO_3^-- N is the only form of nitrogen available (Dima, 2002).

In the second case of NO_3^- - N to form nitrogen gas, N_2 resulting final product. The final product is sometimes accompanied by a partial reduction product N_2O (nitrous oxide) gas.

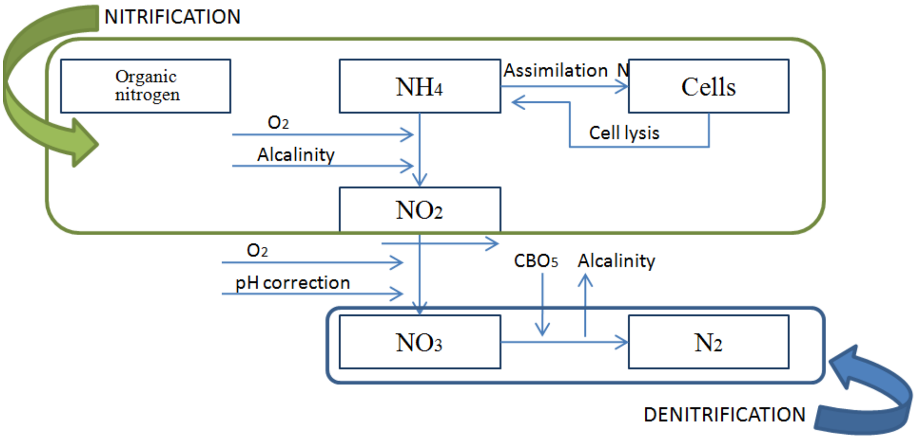


Fig.6 - Scheme of the nitrification - denitrification process

After going through these steps water must have a quality without impact on the environment and meeting the standards for treated wastewater. If emissary can't provide strong dilution, treated water must be subjected to a complex treatment process.

Tab. 3 - Advantages and disadvantages of capitalization effluent in irrigation

Advantages	Disadvantages
• removal of soil water deficit; • is an economic way for the biological treatment; • allow irrigation development in areas where water sources are scarce; • contribute to increased yields by fertilizing capacity of soils due to the content of N, P, K.	□ Negative effects can occur if the quantities of waste water do not meet quality standards or technical implementing measures; □ watering rules considering the soil moisture rule out the rhythmic use of treated water, implying the need for construction of water storage (additional costs); □ substances to the wastewater nutrients can lead, under certain conditions to excessive vegetative growth;

	presence of pathogenic bacteria and viruses.

Conclusions

In the absence of water, the solution turning treated wastewater in agriculture can be considered as an alternative to help reduce water stress.

Climate changes on soil:

- increased erosion and the washing fluid/leachate nutrient, due to volume modify and rainfall intensity;
- soil structure and texture changes, because of increased tendency of disintegration /deterioration under the influence of climatic excessive factors;
- reducing the quantity and quality of soil organic matter, because of the reducing photosynthesis in plants and concomitant reduction rizodeposit;
- the reduction of soil biota biodiversity due to temperature increase and water content reduce;
- salting of soils, because of the increased evaporation processes.

The condition to apply irrigation with wastewater is to adapt the technological processes to eliminate hazardous factors to health (microorganisms, bacteria, viruses, heavy metals) to fit the relevant legislation (treatment with tertiary stage).

After passing through this stage, water presents a quality without impact on the environment and meet the standards to be considered good for irrigation.

Agriculture is an important user of water, economically viable and market competitive. To fit in sustainable development, the agriculture will require technologies and new equipment for more efficient recovery of irrigation water, it will use more unconventional water resources and it will comply the quality management requirements.

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