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Faculty of Mechanical Engineering
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PROCEEDINGS

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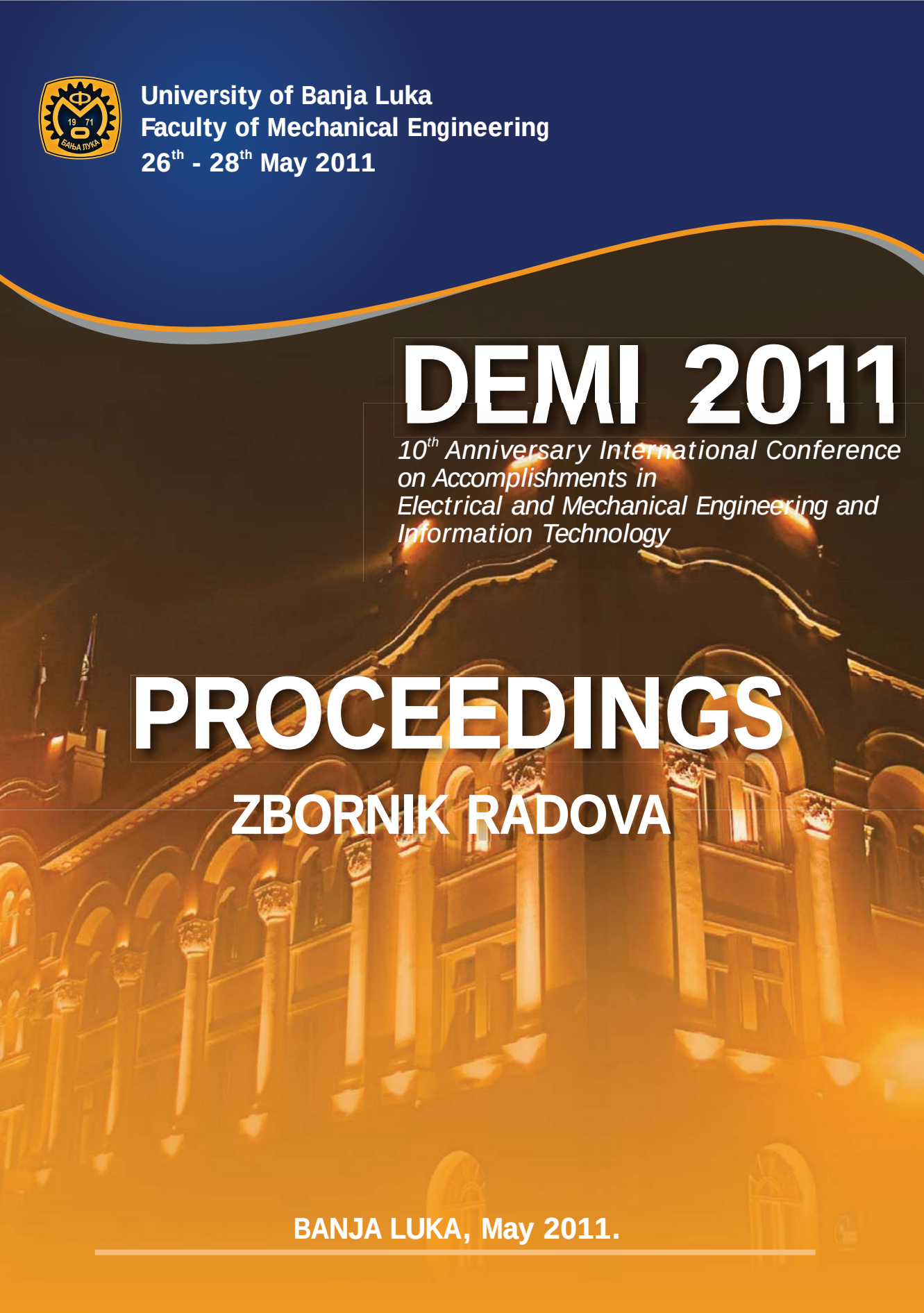

BANJA LUKA, May 2011.

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CONTENT

NATURAL SYSTEMS OF WASTEWATER TREATMENT IN SMALL SETTLEMENTS

Jasmina Skerlic[1], Vanja Sustersic[2], Danijela Nikolic[3]

Summary: *A small group of settlements include settlements with less than 5 000 inhabitants. In these settlements, it is recommended natural treatment systems for the wastewater treatment. In the most of cases, this system is land natural treatment systems. It is a complex (biological, chemical and physico-chemical) process of removing the pollution of waste water, which occurs at the surface and upper levels of the soil. The land is used as a process of tertiary treatment of waste water, primarily for the removal of nutrients, or as a secondary treatment process, for removal the organic pollution of waste water. The most represent treatment systems are: irrigated land with waste water, rapid infiltration of waste water through the soil, and spreading of soil with waste water.*

Key words: *wastewater treatment, decentralized systems, large settlements*

1. INTRODUCTION

During the past decades, increasing attention has emerged for environmentally sound, sustainable, low-cost and effective wastewater treatment technologies based on ecological principles, namely ecological technology or natural treatment systems. The environmentally-sound attribute of ecological technology is its capability of resource recovery and reuse (water and nutrients) while at the same time consuming little or no energy and chemicals. The different types of natural treatment systems correspond with the different ecosystems along the land-water gradient, starting from the land-side with high-rate infiltration fields, overland flow systems, constructed wetlands and finally waste stabilisation ponds or lagoons.

It is recommended Natural Treatment Systems for wastewater treatment of small villages, which are mostly cases of so land treatment systems. It is a complex (biological, chemical and physico-chemical) process of removing wastewater pollution which occurs at the surface and upper levels of the land. The purification involved microorganisms that live in soil and plants that the growth or are there planted, then the interaction between the soil and waste pollution water, such as chemical precipitation, adsorption, ion exchange. This complex process is held the control by

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regulating the amount of waste water used to water the land, to avoid the penetration of untreated wastewater in groundwater or to dreinage into surface watercourses, and to their pollution. In addition, wastewater is added the amount that can be "accepted" the land, and to avoid overcoming anaerobic conditions in the soil, resulting in a decline in the capacity of wastewater treatment.

2. DESCRIPTION OF PROCESS IN NATURAL TREATMENT SYSTEMS

Land can be used as a process of tertiary wastewater treatment (purified in the secondary treatment), primarly to remove nutrients; or as a secondary treatment process for removing organic pollution of waste water. The three most common treatment system are: (i) irrigated land waste water, (ii) rapid infiltration of wastewater through the soil, and (iii) spreading of soil with waste water. The lagoons, where water plants are grown and fish which are then processed into animal feed or used in the industry, can be used for wastewater treatment, where the focus is, usually, on the increase biomass and less on the effect of purification of waste water, which is generally quite weak.

2.1 Irrigation

Irrigation (Fig. 1) is the most commonly used system. It is considered the most reliable and best system of purification of waste water land and provides the best quality of processed waste water. Irrigation may be defined as the application of water to soil for the purpose of supplying the moisture essential for plant growth. Irrigation plays a vital role in increasing crop yields and stabilizing production. In arid and semi-arid regions, irrigation is essential for economically viable agriculture, while in semi-humid and humid areas, it is often required on a supplementary basis. It is usually irrigated arable land, where crops are grown and other crops whose sales reimburse part of costs of such a system of purification. Selection of plants to be grown also depends on the number of factors: the capacity of the adoption of nitrogen, water, and adopted by the tolerance increased soil moisture, resistance to pollution from waste water, and in this respect suitable are various types of grasses.

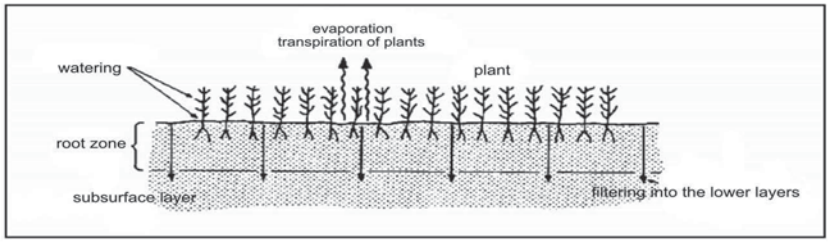

Fig.1 *Purification of waste water irrigation land*

2.2 Rapid infiltration

Rapid infiltration land treatment system consisting of periodic waste water filling of shallow channels or pools from soil exhumed large permeability (sandy and ravelly soil), Fig. 2a, where the water purified during trickling through the layer of soil to

the groundwater levels. If purified waste water can not allows into the groundwater, it is collected by drainage (perforated) pipes Fig. 2b, into the proper channels or pull out the surface through a system of wells, the Fig. 2c.

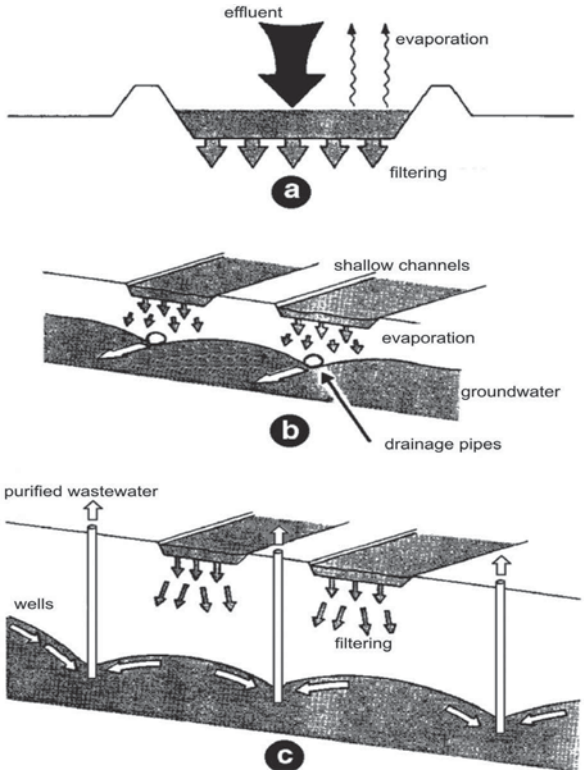

Fig. 2 *Rapid infiltration through soil: (a) scheme processes, (b) drainage pipes, (c) a system of wells*

The largest part of the wastewater is drainage (usually no vegetation). For the treatment of effluent septic tanks, in the processes of wastewater treatment of the smallest settlements, this procedure could come into consideration, provided that the problem would not be important odor emissions.

Rapid infiltration is less restrictive than other types of land treatment. Rapid infiltration basins offer the advantage of being less dependent on climate than other natural treatments systems. Vegetation is not a required design element, so the length of the growing season does not impact effectiveness unless a high degree of nitrogen removal is necessary. However, the life spans of rapid infiltration systems have been reported to be potentially reduced due to saturation of the soil with phosphorus and heavy metals.

For onsite wastewater treatment, sand mounds are more common than basins, when rapid infiltration is implemented. Sand mounds are used only when the upper portion of the soil profile is conducive to rapid infiltration, and may be appropriate

where soil permeability is too slow or too fast, or where shallow bedrock or a shallow water table exists.

2.3 Overland flow

Overland flow is a treatment system where a treasure inclined smooth soil low permeability, overgrown with vegetation cover, on top of the slope poured with the wastewater that flows in a thin layer, gradient, down the slope and collects at the base.

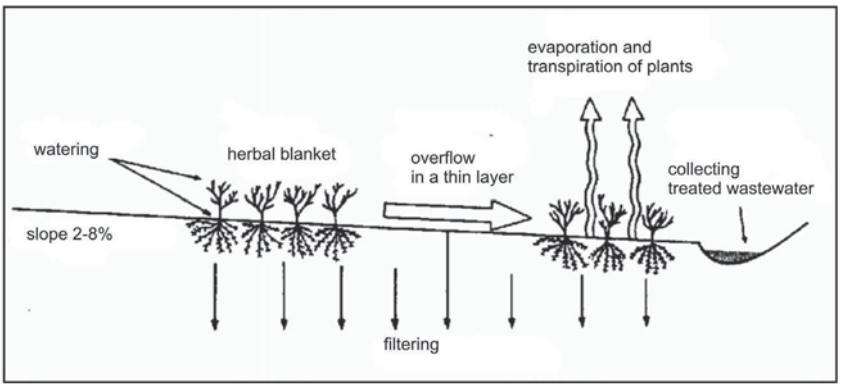

Fig. 3 *Purification of waste water overflows the land*

The choice of plants is essential to in this system because it significantly influences the capacity and filtration efficiency.

Land treatment systems are characterized by relatively large investment costs but low operation costs. It is recommended that received biomass is not used for human consumption, or must first establish whether the biomass has a pathogenic microorganisms and toxic substances (heavy metals, pesticides, etc.) originating from waste water. The overland flow process differs from the other land treatment processes in that treatment of the effluent occurs on or above the land surface, rather than in the subsurface. In this process, effluent is spread evenly along the top of a vegetated slope. The slope is gentle enough so that sheet flow occurs over the vegetated land, where chemical, physical, and biological processes improve the quality of the effluent. Sedimentation, filtration, and biochemical activity are the primary treatment processes at work in overland flow. Besides controlling erosion, the vegetation removes nitrogen and other nutrients from the effluent, and also filters out suspended solids. Microorganisms such as bacteria and algae, attach to the vegetation and break down dissolved organics. Additional biochemical activity occurs in the top layer of saturated soil. Overall, effluent treated by overland flow is of relatively high quality. Suitability for discharge to streams, however, will be dependent on local discharge requirements, as well as the characteristics of the receiving water body. Evapotranspiration and percolation into the subsurface, provides some reductions in the amount of water that is eventually discharged. Percolation, however, is necessarily limited by the low-permeability soils that are required at the treatment site.

Overland flow depends on sheet flow across the land and vegetation surfaces, so this option can be implemented only where underlying soils will restrict infiltration.

For this reason, overland flow can provides an alternative to the other land treatment options, where site conditions limits the use of drainage fields, spray irrigation, rapid infiltration, and other methods that require percolation into the subsurface.

2.4 Wet fields

Wet fields, or construcred wetlands can be (i) systems with free water surface (free water surface systems) and (ii) systems with the flow of water below the surface (subsurface flow systems) such systems are the advocate in practice.

Analysis should include investment and operating costs during 15 years (cost cutting, waste deposit plants, planting new plants, control waterproofing, root replacement filter layer, etc.). The analysis should to cover the costs and benefits of the community bearing in mind the purpose of fertile land that would be used for such purposes. In America, for example, wet fields with free surface over, are used rarely for primary treatment, because of potential exposure to pathogens, but generally for effluent polishing lagoons, filters etc. Fields with the flow below the surface are used mostly for the treatment of primary effluent the secondary standards, but it should be noted that the application of this technique only in development and that it is necessary for her to do a careful assessment of benefits and costs to in investment and in the long-term exploitation. In this regard special attention should be given to certain types of pollution such as nutrients, oil and grease, metals and micropolutants organic (detergents, various chemicals used in households, pharmaceuticals, metabolites). Removal of nitrogen that is achieved by wet fields according to the literature is good, although the natural level is usually higher than 1 mg/l, organic nitrogen accumulate in vegetation and may later be released or recycled.

Nitrate removal is generally good. Removal of phosphorus by wet fields is not entirely efficiently. As for the metals data are not enough and they are rare and diverse. So eg. removal efficiency for cadmium ranges from 75-99%, 40-96% for copper, 0-86% for lead, 49-88% for nickel, and 33-96% for zinc. The accumulation of toxic organic and inorganic micropolutants can form toxic fields. Worrying is their ability to penetrate into groundwater, and even the fact that they are detected in the drinking water. It was found that irrigation and filtration through the soil can cause water pollution, certain medications. An important aspect of the assessment the impact of this technology is the problem with climate factors (eg. the appearance of large rainfall that cause flooding and major changes in load swampy fields or sensitive plant and animal species in different physical and chemical factors).

3. BENEFITS

Benefits of natural treatment systems are needed primarily to less energy for these systems, because most of the energy taken from the natural environment; but the potential weaknesses of these systems are numerous, as are the systems that must be design and create exactly the present location, its geography, microclimate, soil, and other characteristics, with carefully chosen and dimensioned plant for the pretreatment of wastewater.

Creating such systems requires multidisciplinary knowledge, the experts in different fields; keeping the process a lot difficult, because of the sensitivity of the process on the environment, and process control is a demanding and relatively

expensive. These are all reasons to possible wider use of natural processes of purification of waste water treatment of small settlements can not be approached without a comprehensive and long-term monitoring test facility, from which order to collect enough data for the relevant assessment acceptance of natural purification process for wastewater treatment of small settlement.

Selection of any purification systems for a small settlements, is of crucial importance to the plants in small areas are not left to itself, because it is difficult, practically impossible to provide all the necessary logistics for the operation of these systems.

4. CONCLUSION

Natural wastewater treatment systems are simple, cost-effective and efficient methods to purify the growing amount of wastewater produced by our society. They can be applied as secondary or tertiary purification treatment, allowing the removal of most of the bacteria, microorganism and the destruction of the organic matter. Among them phytodepuration, lagoon purification and storage in tanks gave good results in terms of yield and are quite diffused all over the world.

The selection of a natural wastewater treatment system requires the consideration of a number of factors, including wastewater volume and pollutant characteristics, site soils and geology, and climate.

Their extreme simplicity in building, operation and maintenance make these systems competitive with the conventional (sewer) wastewater treatment methods.

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