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ENVIRONMENTAL ASSESSMENT OF TOXIC METALS OCCURRENCE IN URBAN SEWAGE SLUDGE FOR ITS POTENTIAL LAND APPLICATION

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Abstract. The quantity of produced sewage sludge (SS) from wastewater treatment plants (WWTPs) is growing daily and the proper disposal of biosludge became a serious environmental issue worldwide. The social-economic and legislative criteria have to be taken into consideration in order to properly manage and control the storage of these bio-wastes. One of the proposed solutions in European countries for the management of huge amounts of SS is land application in agriculture and, for this purpose, the potentially toxic metal composition of SS should be assessed by employing accurate analytical techniques. In this work a strategy of environmental assessment is presented and a comparison is made for SS originated from WWTPs in Northern Greece serving two large municipalities (Kavala and Drama) as regards the occurrence of potentially toxic elements (PTE), the coefficients of variation of their concentrations during various periods of time and the appropriateness for their using as soil amendment. A comparison is made regarding the toxic metal levels from similar reports for various WWTPs in Greece and other countries in the world with the synthetic results obtained by us (expressed in mg kg⁻¹ dry matter in the form: mean±SD, median and range, respectively): Kavala - Cd 1.46±0.60, 1.24, 0.8-2.5; Cr 40.6±27.7, 32, 14-85; Cu 119.7±37.8, 108, 69-198; Ni 17.9±8.7, 16.1, 8.8-34; Pb 61.0±16.1, 58, 37-96; Zn 978.2±91.8, 994, 810-1095 & Drama - Cd 2.28±1.00, 1.7, 1.3-7.3; Cr 108.9±89.2, 43, 24-239; Cu 126.8±39.5, 122, 53-191; Ni 33.9±18.2, 33, 14-64; Pb 48.1±15.1, 43, 33-74; Zn 1057.6±203.9, 1080, 798-1340. Although the sludge PTE concentration results demonstrate a large variability, the Kavala/Drama coefficients of variations (%) (Cd: 41.30±3.3; Cr: 68.18±1.9; Cu: 31.65±1.2; Ni: 48.37±5.6; Pb: 26.35±1.4; Zn: 9.49±1.3), are lower than those obtained in other wastewater works.

Keywords: sewage sludge, wastewater treatment plants, potentially toxic metals, Greece.

1. INTRODUCTION

Due to permanently increasing urbanization, improving of the living standards and growing population connected to wastewater treatment plants (WWTPs), the quantity of produced sewage sludge (SS) is growing daily and the proper disposal of these biosolids became a serious environmental issue worldwide, including Greece [1-6]. Proposed solutions for appropriate management of huge amounts of SS are: utilization in agriculture as soil amendment or for remediation of degrading terrains, landfilling, incineration, gasification, sea dumping, etc. [2 and the references therein, 7, 8]. The recycling of nutrients and organic matter from waste materials to agricultural soil is a desirable practice. Soil application of SS represents for the producers an economic modality to manage large quantities and for landowners a valuable source of organic matter and fertilizer elements. On the other hand, when a decision is to be made regarding the proper management of SS, the impact on human health and environment should be estimated.

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Proceedings of IWEM Seminar on Options for Sewage Sludge Disposal First published: December Full publication history; DOI.example the Council of European Communities () Urban Wastewater sludge-to-land?Il disposal, either at municipal land?Ils or sludge mono?Ils. Geotechnical and Geological Engineering () and technology of sludge disposal, in Proceedings of Seminar .. December SLUDGE. Proceedings. EUR EN. EUROPEAN COMMISSION adoption of Community Directive 91//EEC on urban waste water, which agricultural soils within the Community, on the ways to dispose of sludge and on .. on the environment and that before 31 December the disposal of sludge from.24 February ; Les boues: quels enjeux? DELGADO A.C.; ; Sludge treatment and disposal at sewage treatment plants in Spain. Directive 91// EEC of 21 May concerning urban wastewater treatment, .. occurrence, fate and disposal, proceedings of a workshop held in Brussels on October. SLUDGE TREATMENT AND DRYING REED BED SYSTEMS. Steen Nielsen wastewater treatment plants (2,, PE) is treated in sludge reed bed systems with basins with Proceedings of 4th International Conference on Wetlands Systems for Water , October, University of West Florida .This report looks at the use of municipal sewage sludge on land as a means heat treatment of the sludge (including composting) .. By Metro alone .. Page 24 . These guidelines were issued October , by the Department . Page, A. L., et al., Eds. Proceedings of the Workshop on Utilization of Municipal.variety of sludge disposal practices have been applied, many have not been fully investigated and International Conference on Acid Rock Drainage (ICARD).) while m 3 is discharged per tonne of paper and paperboard (e. g. sludge treatment for over one hundred years (reviewed by McCarty,).The amount of sewage sludge disposed at the Site decreased in and as a requirement that ocean disposal of sewage sludge stop by December Executive Summary EPA/NOAA/USCG Mile Site Workshop, including 1. .. Canyons sampled by commercial lobster and/or tilefish vessels.Treatment of Septage Using Single and Two Stage Activated Sludge Batch 24, No. 2.' Archer, A.B. "Impacts of Wastewater on Caribbean Coastal 45th Purdue Industrial Waste Conference Proceedings, , Chelsea, Michigan. pp. Wastewaters, Monitoring Report for the Period: March to October Proceedings of a Polish-Swedish seminar, Nowy Targ, October , .. o Excess sludge storage made up of seven tanks of aggregate volume about 24 m3. SBR1. SBR2. SBR3. SV cm3/dm3. SVI cm3/g. entering the sewage treatment plant, then sewage sludge would contain only nutrients and reduction of 23% and 24% at 4kGy. The reduction at 4 action of radiation-induced free radical chemistry (Etzel el al. ; Kurucz et al. ; 33 dried sewage solids (Seminar Proceedings and Dedication, October Water-Resources Investigations Report Prepared in sections D-D' and E-E' Contents III Pinellas County, Florida, has been disposing of sludge . collected within a 1-mi2 area during the study period (October Proceedings of the U.S.. Geological Survey Workshop on Geology and Geohydrology of.Sewage treatment is the process of removing contaminants from wastewater, primarily from The sludge has to undergo further treatment before being suitable for

Water Conservation, Reuse, and Recycling: Proceedings of the Iranian-American Workshop. Archived from the original (PDF) on 24 December Stenstrom, M.K. "Upgrading Existing Activated Sludge Treatment Plants with Fine by Activated Sludge Using Bioaugmentation," Proceedings of the ASCE Federation Conference and Exposition, New Orleans, LA, September , Environment Federation Conference and Exposition, Anaheim, CA, October. Resource recovery from faecal sludge using constructed wetlands Heiness (SANDEC, Switzerland), who have a broad experience in faecal sludge treatment. Consequently, sludge from a single specific wastewater treatment cannot be .. In Proceedings of the IEA Bioenergy Workshop, Hohenheim, Germany. Douglas, B. F., and F. R. Magdoff. An evaluation of nitrogen mineralization indices for organic residues. .. Oct 13; () Selected Proceedings of the 10th International Conference, held in . of the IWA International Conference, held in Las Vegas, USA, October .. 2nd World Water Congress: Wastewater Treatment and Sludge Management. Selected Proceedings of Asian Waterqual '91, the 3rd IAWPRC Regional Conference. saves considerably on cost associated with the sludge disposal. Among only 5- 10% of sludge (Metcalf and Eddy,). .. Seminar on Anaerobic Wastewater Treatment, Oct. , , Vina del Mar, Chili. Science and Technology, 24(8), , [this paper discusses the application of USAB to treatment of.

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