POTENTIAL AND PLANNING FOR THE SAFE REUSE OF MUNICIPAL WASTEWATER FOR THE IRRIGATION IN SOILS AND PLANTS IN WESTERN GREECE.

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Introduction

Care in the reuse of processed liquid wastes from wastewater treatment plants (WWTP) plays a major part in the protection of ecosystems which are used as final receptors of urban wastewater and provides an environmental answer to the creation of green areas around the WWTP. In Western Greece have been studied the safe reuse of WWTP for irrigation in the plants, crops and soils. In research areas have been examined all parameters that affect the system like chemical characteristics and mineral composition of municipal reclaimed wastewater (MRWW), climatic conditions, geological and hydrological data and measured the concentrations of macro and microelements in soils. In this paper presented the general of various parameters of WWTP in Western Greece (Fig. 1) and the results of analyses of processed wastewaters and soils in the area of WWTP in Messolonghi, Greece.

In the developing countries, the irrigation of the soil by using municipal reclaimed wastewater (MRWW) have always been one of the principal means of satisfying the irrigation needs of cultivations. The use of urban wastewater for irrigation projects has also become the practice in California, USA, from the 1980. Until 1987, 63% of the wastewater production was used in agriculture [1]. The reuse of wastewater in the Mediterranean countries is the useful practice for the last years. Mediterranean countries as Cyprus, Israel, Italy, Spain, France, Egypt, Tunisia, Morrocco, Greece reuse the wastewaters in agriculture. Wastewaters in most countries of the near East Region have been studied by [2]. In Greece have been studied the safe reuse of wastewaters for irrigation in plant species and soils in Agrinion area, Attica, Patras and Corfu [3].

Materials and methods

Samples of processing wastewaters and soil were taken from the WWTP of Messolonghi and laboratory analyses were made. In different samples of processing wastewaters, which were taken on different dates, the determination of elements was made through the process of atomic adsorption spectroscopy furnace technique. The equipment that was used was 2.100 Perkin Elmer.

In wastewaters measured, pH, SAR (Mmhos/cm 25^{o}C), cations Ca^{++} and Mg^{++}, Na^{+} (Me/L), N the anion Cl^{-}, and finally the concentration of elements Mn, Zn, Fe, Cu, Pb, Cd, Cr, B, As, in ppm.

In the Soil were measured, pH, electric conductivity (Mmhos/cm) the organic matter (%), P (Olsen) ppm K, Ca, Mg and the concentrations of elements B, Mn, Zn, Fe, Co, Ni, Cd, Pd, Cu, in ppm. Soil samples were air dried ground with a pestle and mortar and finally dried at 50 ^{o}C for 4h. Replicate samples (0.25g sieved and ground in a team that will have grain size of 100μm) were digested by Aqua Regia Acid HCl/HNO_3 and analyzed for the elements by inductively compiled plasma emission spectroscopy (ICP-AES).

Results and discussion

Using statistical data analysis techniques we were able to analyze and interpret our experimentation data. So, for the wastewaters we have that statistically there is important difference among the samples of wastewaters for Conductivity, pH, SAR, Ca, Mg, Na, Mn, Cu, Zn, Cr, B, Fe, As, N, P, K and Cl at the 0.05 significance level (Table I). For the soils we have that statistically there is important difference among the samples of soils for pH, $CaCO_3$, Organic matter, B, P, K, Ca, Mg, Zn, Mn, Fe, Cu, Cd, Pb and Zn at the 0.05 significance level. Additionally we observe that there is not important difference among the samples of soils for Co, E.C., and Ni at the 0.05 significance level (Table II).

The estimated values of physicochemical properties and concentrations of elements of wastewaters and soils for the area of WWTP in Messolonghi, Greece, are in the limits that the WHO (World Health Organization) has defined and besides the wastewaters can be reused for the treatment of plants.

Fig. 1. WWTP of the region of Western Greece.

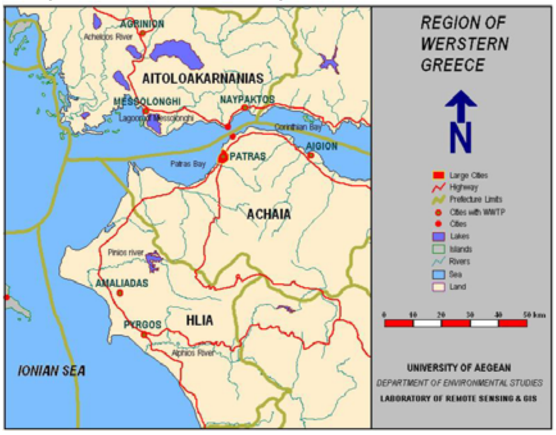

Table I. Physicochemical properties and concentrations of elements of wastewaters for the area of WWTP in Messolonghi, Greece.

SAMPLES OF WASTEWATERS	1	2	3	4	5	P-Value
Conductivity μS/cm (25° C)	1367	1504	1086	982	1190	0
pH	7,41	6,91	8,82	7,86	7,67	0
SAR	4,19	4	3,98	4,1	4,6	0,001
Ca (mg/l)	71	80	92,9	92,8	108	0
Mg (mg/l)	23,4	24,7	17,7	14,9	21,6	0
Na (mg/l)	160	160	160	160	200	0
Mn (μg/l)	97,3	150	200	30	<20	0,045
Cu (μg/l)	4,1	2,5	3,3	2,2	2,2	0,002
Zn (μg/l)	100	65	205	61,8	49	0,028
Cr (μg/l)	< 1,3	< 1,3	< 1,3	< 1,3	< 1,3	0
B (mg/l)	1,1	0,9	1,9	1,3	0,9	0,003
Fe (μg/l)	210	256	20	120	40	0,049
As (μg/l)	0,6	< 0,3	1,38	0,97	0,4	0,021
N (mg/l)	13,5	17,5	14	11,5	6	0,003
P (mg/l)	0,42	0,6	0,42	0,46	0,18	0,004
K (mg/l)	25	24	13,1	11,6	13,6	0,004
Cl (mg/l)	320	340	203,2	178	230	0,001

Table II. Physicochemical properties and concentrations of elements of soils for the area of WWTP in Messolonghi, Greece.

SAMPLES OF SOILS		1	2	3	4	P-Value
Mechanics evaluation		L	L	CL	CL	
pH		8,47	8,36	7,85	8,25	0
Free CaCO3		3,5	7,9	11	7	0,018
E.C. mmhos/cm 25 o C		2,98	1,645	49,8	0,65	0,335
Organic substance O.O %		1,65	2,38	0,98	3,95	0,039
Concentr. of basic elements	P (Olsen) ppm	17,32	10,98	26,16	36,61	0,026
	K ppm	310	320	390	410	0,001
	Ca me/100 g	3,55	4,49	4,75	4,13	0,001
	Mg me/100 g	1,01	0,5	0,98	0,7	0,007
Concentr. of microelements	B ppm	4,88	2,43	1,43	2,54	0,031
	Mn ppm	6,22	7	3,92	5,05	0,004
	Zn ppm	1,54	0,84	1,92	1,97	0,009
	Fe ppm	16,77	28,27	9,27	28,72	0,022
	Cu ppm	2,21	3,59	1,88	3,34	0,007
	Cd ppm	0,05	0,11	0,11	0,1	0,008
	Co ppm	0	0,1	0,08	0	0,186
	Ni ppm	0,47	0,73	0,07	1,35	0,093
	Pb ppm	2,86	2,69	4,94	2,92	0,008

Conclusions

The reuse for irrigation is expected to substantially contribute to the prevention of any future degradation by heavy metals of the wastewater's final receiver, the sea of Messolonghi, Greece, with the ultimate goal of the environmental protection of the water receivers.

Acknowledgements

Work supported by the program "Pythagoras II - Funding of research group in University of Ioannina with P.C. 1920 and MIS 97444.

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