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Agricultural Water Management 66 (2004) 35–47
Agricultural water management
www.elsevier.com/locate/agwat

Water resources management in Crete (Greece) including water recycling and reuse and proposed quality criteria

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Accepted 17 September 2003

Abstract

In Crete, Greece despite having adequate atmospheric precipitation, water imbalance is often experienced, because of temporal and spatial variations in the precipitation, an increase in water demand during summer months and the difficulty of transporting water due to the mountainous terrain. Crete can be regarded as a representative mediterranean region with a relatively high potential for wastewater recycling and reuse. Preliminary estimates show that the implementation of wastewater recycling and reuse plans would lead to water savings of up to 5% of the total irrigation water. The basic aim of this paper is to present views on integrated water resources management in Crete, Greece including the potential for the recycling and reuse of treated wastewater. A preliminary inventory, distribution and mapping of wastewater treatment systems in Crete is also presented. Furthermore, the quality of treated effluents, disposal sites, irrigated areas, and environmental, social, economical, and agronomical impacts are considered. Finally, quality criteria for reuse of treated wastewater in Greece and maybe for other mediterranean countries are proposed.

Keywords: Integrated water management; Quality criteria; Wastewater treatment; Water recycling

1. Introduction

The total annual precipitation in Greece and the total water potential are estimated to be $115,375 \times 10^6\,m^3$ per year and $69,000 \times 10^6\,m^3$ per year, respectively (including water inflows from countries to the north). At the beginning of the 1990s the total water consumption was estimated at $5,500 \times 10^6\,m^3$ per year, but by the end of the decade it was

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0378-3774/$ – see front matter
doi:10.1016/j.agwat.2003.09.004

increased by about 30%. It is estimated that water consumption in Greece increases by more than 3% per year. The major water use category in Greece is irrigation, which varies among water regions from 17% (Attica) to 95% (East Peloponnese), while domestic use ranges from 3% (East Peloponnese) to 66% (Attika), and industrial use from 0.2% (West Central Greece) to 16.0% (Attica) of the total consumption (Tsagarakis et al., 2001). The increased water demand, for both urban and agricultural use, cannot always be met, despite adequate precipitation. Water imbalance is often experienced, especially in coastal and south-eastern regions, due to: (a) the temporal and spatial variations in the precipitation; (b) an increase in water demand during the summer months; and (c) the difficulty of transporting water due to the mountainous terrain. However, on average, there is a relatively high per capita water availability, i.e. around 5,800 m^3/inhabitants per year in year 2000.

Agriculture in Greece has undergone substantial development since 1980 but further development is limited by water availability. Although only one-third of agricultural land is irrigated, the estimated mean annual increase in agricultural water use is only 1–1.5%, consequently there is a great demand for irrigation water. In Crete, for example, only 36% of the available agricultural land was irrigated in 1997. Moreover, major water losses occur (seepage, evaporation, leakage, etc.) during the delivery of the water to irrigated sites and to municipal sites for domestic use (Chartzoulakis et al., 2001). Thus the potential for water recycling and reuse, particularly in south eastern parts of the country, is relatively high.

Greece, with a population of 10.9 million, has to comply with the 271/91/EC directive on urban wastewater treatment (EU, 1991). Today there are over 300 municipal wastewater treatment plants (MWTP) serving about 65% of the country's permanent population. For 21% of the remaining population, it is estimated that 1,800 MWTP will be needed. The remaining 14% of the population is in small villages and remote areas and on site sanitation technologies should be used. However, Greece, as a member of the EU, is required to connect all agglomerations at sensitive areas to sewerage networks with population equivalent (p.e.) $\geq$ 2,000 to MWTP by the end of 2005.

It is necessary that an integrated river basin water management scheme be adopted in response to 60/2000/EC directive (EU, 2000). Marginal waters and especially recycled water should also be considered in such a management scheme. The objectives of this study are to analyze the wastewater treatment status, to investigate the potential for water recycling and its considering as part of an integrated water resources scheme. Potential uses of recycled water are analyzed, particularly for agricultural irrigation on the island of Crete. In addition, quality criteria for the reuse of treated wastewater in Greece and perhaps other mediterranean regions are proposed.

2. Water resources management in Crete

The island of Crete has been characterized by a significant increase in urban and touristic activities, particularly over the past twenty years. As a result of this development the majority of the population has become concentrated in coastal areas. In many cases the infrastructure required to support this type of economical development is inadequate. Although underground water resources are estimated to be sufficient to cover all water needs, the lack of

Table 1
Available water resources and water uses for Crete

Area (km^2)	Precipitation (Mm^3 per year)	Water potential[a] (Mm^3 per year)			Water use[b] (Mm^3 per year)			Consumption index
		Surface	Ground	Total	Agricultural	Domestic and industrial	Total	(%)
8,335	7,690	1,300	1,300	2,600	446	69	515	19.8

[a] Tsagarakis et al. (2001).
[b] Region of Crete (2002).

proper organization and infrastructure has led to serious problems, due to increased water demand particularly during the dry periods.

Water consumption and use in Crete is less than 7% of the annual precipitation. However, in many cases there is a severe water imbalance due to temporal and regional distribution of precipitation. This situation is made worse during the summer months when water demand rises due to irrigated agriculture and increased water consumption as a result of tourism. Furthermore, high percentage of the annual precipitation occurs in the mountainous areas of western Crete and transport of water to the rest of the island exhibits technical, social, and economical limitations. An alternative plan should include integrated water resources management as well as the integration of recycled water originating from the MWTP effluents, into the water resources management. A such plant not only would provide additional water, particularly for irrigation, but also contribute significantly to public health protection to water availability increase, and to coastal pollution protection.

The available water resources and water uses for Crete are shown in Table 1. Note that water use is 515 Mm^3 per year. The total water potential is 2,600 Mm^3 per year, resulting in a consumption index of 19.8%.

3. Wastewater treatment in Crete

The coverage of municipal wastewater treatment in Crete has increased during the past two decades. In 1994 there were nine MWTP in operation but this figure had increased to 13 in 1998 (Tsagarakis, 1999). Today the number of MWTP in operation is 25 and it is estimated that by 2006 this number will have increased to 46. At present seven plants are under construction while other 14 are in the planning stage. There are also four plants which have failed. The failure of those plants is due to the old and not appropriate technology applied and to the scarcity of properly trained technical personnel at these facilities. The number of MWTP according to their status, their total design p.e. and population connected currently to the sewerage system, i.e. served population (s.p.), which reflects the current average flow rate in the hot season, are presented in Table 2. It is estimated that almost all Cretan municipalities with p.e. $\geq 2,000$ will be connected to MWTP providing at least secondary treatment by 2005. The locations of all existing and planed MWTP in Crete and their status are presented in Fig. 1. A higher concentration of plants in the eastern island is shown due to the decently populated area. Notice that 50 and 30% of the total population of the island is staying in the county of Iraklio and the metropolitan area of Iraklio city, respectively.

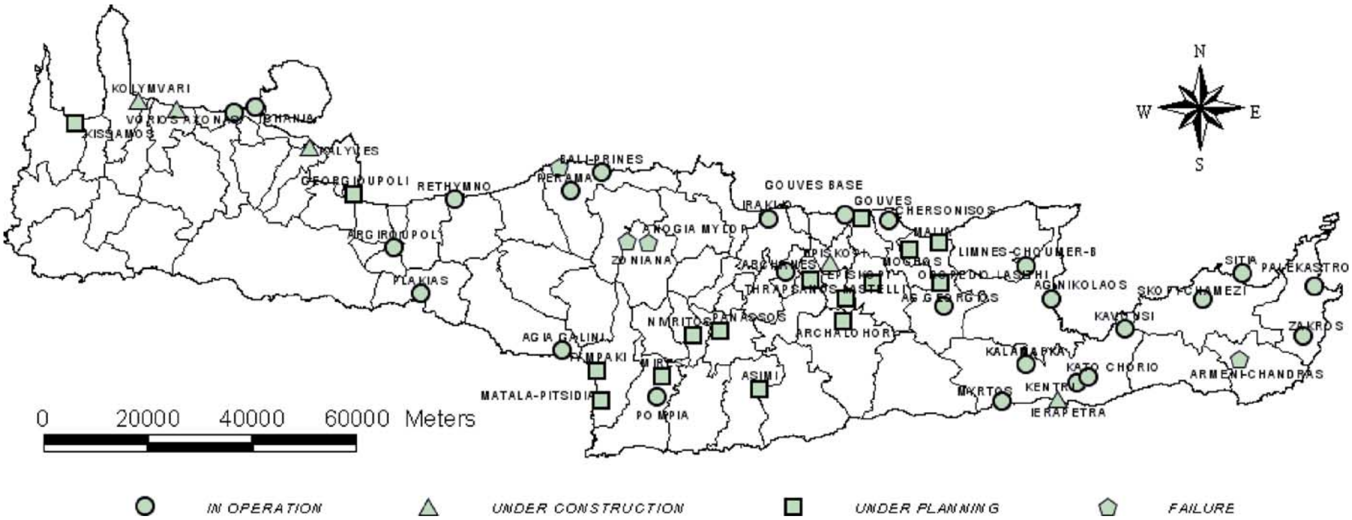

Fig. 1. Location of MWTP in Crete.

Table 2
Development of MWTP in Crete according to their number, p.e. and s.p.

Status	No				p.e.				s.p.		
	1994	1998	2002	2006	1994	1998	2002	2006	1994	1998	2002
In operation	9	13	25	46	49,300	356,250	471,550	712,650	n.d.	267,100	313,900
Under construction	n.d.	6	7	n.d.	n.d.	20,500	124,100	n.d.	n.d.	n.d.	n.d.
Under planning	n.d.	n.d.	14	n.d.	n.d.	n.d.	117,000	n.d.	n.d.	n.d.	n.d.

n.d.: no available data.

4. Effluent recycling, disposal and reuse in Crete

The operational status of MWTP, the quality of treated wastewater, the disposal sites, reuse case studies, and the potential for water recycling and reuse are mainly considered in the following text.

4.1. Operational status

Tsagarakis (1999) has classified the MWTP in operation according to their performance, taking into account effluent qualitative parameters and the effluent quality requirements. Out of 13 MWTP, 42% were operating properly, 41% moderately, and 17% poorly. Today, using the same criteria, out of 25 MWTP, 60% are operating properly, 20% moderately, and 20% poorly. Thus, a significant improvement in the performance of MWTP is indicated. This is mainly due to increased experience and the positive effect of the reforms that were achieved through the new local administrative structure, implemented under Law 2539/97 (Ministry of the Interior Public Administration and Decentralization, 1999).

4.2. Quality of treated wastewater

In general, the quality of the effluent in most of the MWTP appears to be satisfactory (Table 3). On an average basis the BOD_5, SS, and nutrient concentrations in the effluent appear to be on appropriate limits. Also EC maintains less than 2.7 dS/m, i.e. none severe potential irrigation problem (Tchobanoglous et al., 2003). Finally, inorganic constituents and especially heavy metals are in the range recommended for irrigation waters by Tchobanoglous et al. (2003). However, these concentrations do not create a problem because acid soils are very rare in Crete.

4.3. Disposal sites

In the early days of wastewater treatment, Crete, like the rest of the country, had not developed its own local knowledge on wastewater management, and therefore disposal practices were transferred from other countries, with different requirements for disposing of the effluent and water uses (Tsagarakis et al., 2001). Sea outfalls were used mostly at coastal areas for discharging treated effluent. Installations away from the sea usually dis-

Table 3
Qualitative and quantitative data from major MWTP of Crete

	Units	Sitia	Agios Nikolaos	Archanes	Chania	Hersonissos	Ierapetra	Iraklio	Pompia	Rethimno
s.p.		14,000–17,000	10,000–18,000	5,000–9,300	70,000	10,000–40,000	10,000	120,000–145,000	1,200	55,000–60,000
Q_e	m^3/day	2,600–3,000	1,000–2,000	600	17,000	500–3,400	1,800	21,000–24,000	144	7,500
BOD_5	mg/l	18–44	15.7	4–10	5–10	11	7–10	6–10	7.7	5–10
COD	mg/l	25–48	54.0	10–30	29	53	24–30	10–20	18.3	35–45
TDS	mg/l	–	–	–	–	–	–	1,300–1,600	–	1,400–1,600
SS	mg/l	15–28	20.0	5–15	8	4.5	–	5–10	5.6	10–15
NTU		–	–	–	–	–	–	5–8	–	5–10
EC	dS/m	0.65–1.23	1.4–1.9	2.7	1.2–1.9	2.6	1.3–2.2	2.0–2.5	1.5–1.9	2.2–2.5
pH		–	7.7	7.5–8.1	7.50	7.32	7.5–8.1	7.5–7.8	–	7.5–8.0
TKN	mg/l	1.6–3.1	–	–	4.50	2.37	11–16	15–25	17.8	2–3
NH_4–N	mg/l	0.01–0.17	2.1	0.5–4.0	0.40	0.52	0.1–0.5	3.0–6.0	–	0.3–1.0
NO_3–N	mg/l	–	0.9	0.7–5.0	7.10	5.49	11.2–15.1	4.0–8.0	–	0.3–1.0
NO_2–N	mg/l	–	–	–	0.47	–	–	–	–	0.1–0.2
Total P	mg/l	1.8–4.3	–	4.25	7.90	6.06	–	10–15	6.2	3–7
Total K	mg/l	–	–	–	–	27.51	–	–	–	–
Cl^-	mg/l	–	–	170.4	–	576	–	–	–	500
Cd	mg/l	–	–	–	–	0.0048	–	–	–	–
Cu	mg/l	–	–	0	0.013	0.014	–	–	–	–
Fe	mg/l	–	–	0.03	0.15	–	–	–	–	–
Pd	mg/l	–	–	–	–	0.0064	–	–	–	–
Mn	mg/l	–	–	0.02	0.02	–	–	–	–	–
FC	MPN/100 cm^3	90–1,050	–	25	50–500	0–2,100	40–300	0	–	10^6
TC	MPN/100 cm^3	250–1,400	1,000	120	–	0–8,600	90–750	0–30	–	2.3×10^7

Notes. Average values are presented; quantitative variation are due to seasonal tourism.; not all the plants operate disinfection at all times although it is installed.

Table 4
Disposal sites of MWTP at different times in Crete, according to their number, p.e. and s.p.

Disposal site	No			p.e.			s.p.	
	1998	2002	2006	1998	2002	2006	1998	2002
Sea	10	12	13	354,200	460,800	480,800	259,800	277,300
Ephemeral river	6	9	9	17,350	23,600	23,600	5,300	9,250
Irrigation agricultural	3	9	21	4,200	105,250	187,250	2,000	25,350
Irrigation landscape	–	2	3	–	6,000	21,000	–	2,000
Total	19	32	46	375,750	595,650	712,650	267,100	313,900

charged into ephemeral rivers. Other possible disposal sites include irrigation of agricultural and forested land. The number of MWTP falling into each category, their p.e. and s.p. at different years are shown in Table 4. It can be observed that there is a change in the disposal sites from the sea to that of irrigation use. In 1998, 53% of the plants (10/19) were designed to discharge into the sea, while this percentage is 38% (12/32) and 28% (13/46) for 2002 and 2006, respectively. In terms of p.e. these percentages are higher as the larger plants still dispose their effluents into the sea. On the other hand, the number of MWTP that recycle the treated effluent for agricultural and landscape irrigation has increased from 16% (3/19) in 1998 to 34% (11/32) in 2002 and is estimated to be 52% (24/46) in 2006.

4.4. Reuse case studies

Wastewater recycling and reuse in Crete has the potential: to provide new and low-cost sources of water, particularly for irrigation, to prevent coastal pollution, and to define a public policy emphasizing resources and nature conservation. At present the following MWTP are implementing recycling and reuse plans.

4.4.1. Palekastro

In this plant, 280 m^3 per day of treated effluent is used to irrigate olive trees after loading on a 20 m^3 storage reservoir. The irrigation method is trickle irrigation.

4.4.2. Zakros

In this plant, 210 m^3 per day of treated effluent is used to irrigate olive trees, without any storage. The irrigation method is trickle irrigation. During the non irrigation period, effluent is diverted to the adjoining ephemeral river.

4.4.3. Herssonisos

Treated effluent is stored in two reservoirs of total volume 1000 m^3. The main uses of recycled water are (Borboudaki et al., 2002):

- Irrigation of agricultural land: The whole system provides water for irrigation of olive trees covering an area of 2,200 ha. Water is applied to the irrigated land by trickle irrigation.

- Landscape irrigation: Two types of landscape irrigation are practiced: (a) irrigation of ornamental plants on the side slope of the new national road Iraklio–Ag. Nikolaos (6–7 km); and (b) irrigation of 5 ha land planted with ornamental trees and scrubs in the surrounding areas to the five star Creta Maris and 0.5 ha at the four star Silva Maris Hotels. Both of these hotels are located near the city of Hersonissos and are connected to the MWTP sewerage network.
- Fire protection: Water for fire protection is provided through the storage tanks used for agricultural irrigation. In these tanks water level should always maintain above 200 m^3 as this quantity is regarded as the minimum needed in case of fire at the surrounding area.

4.4.4. Archanes

In this MWTP there is planning for tertiary treatment of 40 m^3/h secondary effluent by filtration and UV disinfection and reuse it for irrigation originally of about 14 ha of olive trees and vineyards. An irrigation network of 5.1 km in length is going to be installed for irrigating two irritation zones at different latitudes. One storage tank is going to be installed in each zone of volume 150 and 100 m^3, respectively (Kounenaki, 2002).

4.5. Potential for water recycling and reuse

An analysis has been carried out to estimate the potential use of recycled water in three main irrigation categories given priority as follows: (a) irrigation of agricultural land; (b) irrigation of forested land and fire protection, and; (c) landscape irrigation. An average effluent production of 150 l/p.e.·day is used. The potential for effluent reuse in the years 2002 and 2006 are presented in Table 5. It can be concluded that by reusing the effluent of the existing MWTP, particularly for irrigation of agricultural land, irrigation water could be increased by 5.1% or fresh water used currently for irrigation could be saved. Utilization of the recycled water is related to the existence of nearby agricultural areas and assumes that the relevant infrastructure, like storage reservoirs and distribution systems, will be available. It is estimated that for, the year 2006 this will be 5.7%. For saving additional effluent it is necessary to implement new recycling and reuse projects.

Water consumption for domestic and industrial purposes was 69 Mm^3 per year in 2002, 65 of which is estimated to be for domestic use (Table 1). In addition, Table 5 indicates that more than 26 Mm^3 per year of it can be reused, i.e. about 40% of the water consumption.

Table 5
Potential for effluent reuse of MWTP for various purposes in cubic metre for the region of Crete

Year	Irrigation of agricultural land	Irrigation of forested land and fire protection	Landscape irrigation	Total water reuse potential	Total water use	Percentage of saving over water used
1998	16,490,700	4,026,863	0	20,517,563	458,000,000[a]	4.5%[a]
2002	22,016,070	4,048,763	262,800	26,327,633	515,000,000	5.1%
2006	28,687,229	4,286,925	870,525	34,102,612	597,000,000[a]	5.7%[a]

[a] Estimations based on 2002 data.

5. Proposed wastewater effluent quality criteria

Potential risks of water recycling, EU and WHO initiatives, and the recommended criteria for Greece are presented in the following text.

5.1. Potential risks

By using untreated or inadequately treated wastewater could adversely affect the environment and consequently human health. Thus, among the most important adverse effects on the environment, with the use of inadequately treated wastewater, are pollution of soil and water resources and consequently public health risks.

5.1.1. Effects to soil

On a long-term irrigation strategy, the total quantity of salts applied to the irrigated soil with the applied water should be equivalent to the salts uptaken by the crop plus the amount leaking from the soil. Soil salinitization is common in arid and semi-arid regions, where water could be saline and salt concentrations could be further increased through the wastewater treatment processes. Thus, in such areas additional criteria for EC and SAR must be applied.

In addition to the soil salinity and toxicity of both specific ions, such as Na^+, Cl^-, also B^{3+} should be considered as well as heavy metals. Also, by adding heavy metals in vedoze soil zone, their concentration and solubility in the soil solution under certain conditions will increase with time and following some years of irrigation, it is possible for toxic levels to develop in plant tissues (Angelakis, 2003). However, the water supply economy in Crete depends on the groundwater. Thus, water supply quality is very good with very low EC (<1 dS/m) resulting also in relatively low EC and TDS concentrations in the treated wastewater (Table 3).

5.1.2. Effects to water resources

Most pathogens present in wastewater and treated wastewater effluent are retained in the top few centimetres of the soil, particularly in fine textured soils (Tzanakakis et al., 2003), and the horizontal movement distances under uniform soil conditions, are normally less than 20 m. Also, the depth of groundwater table even during the winter period areas appears to be very deep. Thus, the potential contamination of soil and consequently of the groundwater is depending on the survival time of the specific pathogens during its residence time in the soil. However, the concentration of heavy metals in the treated wastewater is relatively low due to the existing of small to medium communities and without industrial facilities connected to the sewerage network (Table 3).

5.2. EU initiatives

In Greece no guidelines or criteria for wastewater recycling and reuse have yet been adopted. It should be mentioned that secondary effluent quality criteria are used for discharging purposes according to the Health Arrangement Action of 1963 (Ministries of Interior and Public Health, 1965) and are independent of the disposal, recycling, and reuse practices. Moreover, no water recycling and reuse regulation exists at the European level. The only reference to it is in article 12 of the European Wastewater Directive 91/271/EEC (EU, 1991) stating: “Treated wastewater shall be reused whenever appropriate.” To make this statement reality, common definitions of what is “appropriate” are needed. Thus, the need for establishing wastewater recycling and reuse standards at both the European and national level is obvious (Angelakis et al., 1999).

5.3. WHO initiatives

The WHO guidelines were derived from the review of epidemiological studies of wastewater reuse, along with what was achievable by wastewater treatment processes (Havelaar et al., 2001). Studies are available on the disease risk from some pathogens and the illnesses risk on the exposure to raw wastewater and excreta, and on the risk to farm workers in developing countries (Blumenthal et al., 2001). However, there is little data available on the effect of the use of treated wastewater on the general public, particularly in relation to consumption of vegetable crops. Where epidemiological evidence is not sufficient to allow the defining of a level (microbiological quality) at which no excess risk of infection would occur, data on pathogen removal by wastewater treatment processes, pathogen die-off in the field, and pervading guidelines for water quality are taken into account (Gerba and Rose, 2003). WHO (1989) guidelines are under revision. The first draft is expected to be published early of 2004.

5.4. Recommended criteria

More recently a group of experts in the water recycling area have proposed international guidelines for recycled water based on draft Australian guidelines (Anderson et al., 2001). These guidelines are based on the level of FC and treatment received by the wastewater. In Greece a preliminary study for establishing quality criteria has been undertaken. A summary of those criteria are given in Table 6. As indicated, these criteria are based on similar principles to those of Anderson et al. (2001) and Gerba and Rose (2003). Any application of the criteria (Table 6) should be associated with the following general comments:

(a) A minimum sample of four should be considered.
(b) Student’s *t*-test should be met.
(c) Values for criteria indicated must be conformed at 80% of the samples per month, based on average values.
(d) Control of odor is required in cases of application to the soil surface in and/or closed to residential areas.
(e) Criteria for irrigation are not applicable in the cases of subsurface irrigation.
(f) For agricultural irrigation avoidance of using disinfection with Cl^- should be taken into account. In addition, the following should be considered: (i) integrated management of water resources; (ii) seasoned storage which improves water quality and; availability, and (iii) quality supervision of the sampling method, the frequency of sampling and the reliability of analyses.

Table 6
Proposed minimal microbiological and physical criteria for reusing of reclaimed wastewater in Greece

No	Water quality criteria	Recommended uses
1st	I.N.[a] $\leq$ 0.1 eggs/l FC $\leq$ 10 cfu/100 ml TSS $\leq$ 10 mg/l	(a) Residential areas with high public contact (b) Toilet flushing and air conditioning (c) Car washing
2nd	I.N. $\leq$ 1 eggs/l FC $\leq$ 100 cfu/100 ml TSS $\leq$ 20 mg/l	(a) Ponds, bodies of water, and streams with high public contact[b] (b) Fountains and other recreation places (c) Streets cleaning and fire-fighting
3rd	I.N. $\leq$ 1 eggs/l FC $\leq$ 1000 cfu/100 ml TSS $\leq$ 35 mg/l	(a) Irrigation of fodder crops for livestock[c], of crops for canning, of vegetables to be eaten cooked, of plant nurseries, etc. (b) Aquaculture
4th	I.N. $\leq$ 1 eggs/l FC $\leq$ 10,000 cfu/100 ml TSS $\leq$ 35 mg/l	(a) Irrigation of wooden areas, industrial wood areas, greenbelts and areas where the public is not allowed to enter (b) Industrial use (except for the food industry)[d] (c) Ponds, bodies of water and streams where public contact is not allowed
5th	I.N. $\leq$ 1 eggs/l FC $\leq$ 100 cfu/100 ml TSS $\leq$ 10 mg/l	(a) Groundwater recharge (direct injection and/or surface spreading)[b,e,f]

[a] I.N.: intestinal nematodes including the following families: *Strongyloides*, *Trichostrongylus*, *Toxacara*, *Enterobius*, and *Capillaria*. Limits are not applicable for most of the uses.
[b] Limits for $NO_3{}^-$ should be required, such as TN $<$ 15 and $<$50 mg/l for groundwater recharge (direct injection and surface spreading, respectively)s and NO_3^-–N $<$ 100 mg/l for ponds and water streams.
[c] Limits for *Taenia* sp. ($<$1 eggs/l) should be required.
[d] Limits for industrial cooling for *Legionella phennophila* should be required.
[e] A minimal depth for the groundwater table of 5 m is required.
[f] In the case of direct injection particularly to a potable groundwater aquifer, the criteria for potable water should be applied.

(g) According to Greek legislation, recycled wastewater can be reused for irrigation except for the irrigation of plants used for human consumption.

As non potable reuse will long remain the goal of the large majority of reuse projects, the proposed criteria for municipal wastewater recycling and reuse for Greece and probably for mediterranean region are focused on microbiological hazards. Treated wastewater quality criteria should reflect the potential for regional variations in climate, water flow, and wastewater effluent characteristics and should be planned to protect individuals against realistic maximum exposures. Intestinal nematodes are of major concern in south mediterranean countries. For the northern (mainly EU member) countries only FC or *Eshcheria coli* should be considered. In addition proposed criteria should be: (a) realistic in relation to local conditions (epidemiological, social-cultural, and environmental factors), (b) affordable, (c) practical, (d) simple, (e) flexible, and (f) enforceable.

Establishing common mediterranean criteria for municipal wastewater effluent reuse is a challenge because of the absence of comprehensive international criteria and of a scientific consensus on the approach that should be adapted to issue such criteria. This has led to inconsistencies between the criteria that are already implemented in some mediterranean countries.

6. Conclusions and recommendations

Greece is characterized by relatively high overall water availability. However, there are water regions under water stress. In the water region of Crete the water resources availability is limited due to temporal and spatial variations of precipitation. Also, the continued increase of domestic water and agricultural demand can only be met through an integrated water management scheme in which non conventional water resources (such as recycled water) should be included. This study reveals that by proper management and reuse of the effluents from the existing MWTP in Crete an overall water saving up to 5.1% should be achieved. This percentage will increase substantially as the number of MWTP is increased. Criteria for the safe use of treated wastewater particularly in agriculture are required to maximize public health benefits and at the same time allow for the beneficial use of scare resources. Effluent quality criteria for intestinal nematodes, FC, and TSS should be used for the safe application of water recycling and reuse, according to the recommended uses. These criteria directed to agricultural and landscape irrigation and groundwater recharge. Industrial reuse is very seldom practiced in Greece and in the most mediterranean countries. It is believed that proposed criteria are well balanced among the health and environmental protection and the feasibility to be implemented in the most mediterranean countries.

Acknowledgements

Part of this paper was presented at the Regional Symposium on Water Recycling in the Mediterranean Region, IWA, Iraklio 26–29 of September 2002. The first author is sponsored by the Greek National Scholarships Institute.

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