Evaluation of the Turkish Reuse Standards and the Compliance Status

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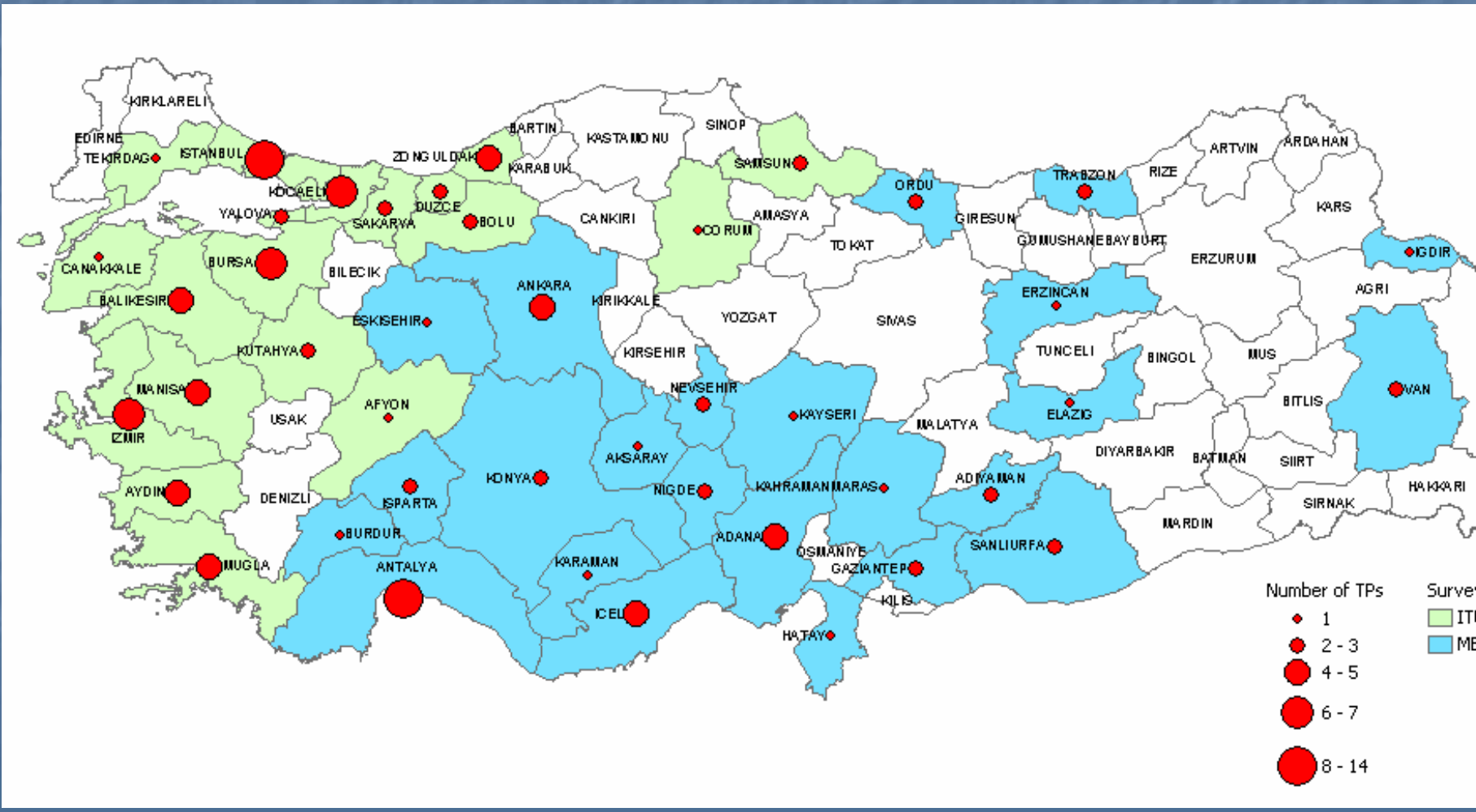
Turkish Wastewater Statistics -1 Source: SIS

- total of 3215 Municipalities
- 1327 municipalities own sewer systems
- 60 % of the total population is served by sewerage systems
- 35 % of population is connected to a treatment plant
- total of 1.6 billion m3 wastewater is treated to some degree annually
- total of 129 treatment plants, with capacities 3000 PE or higher, exist in the country
- 78 of the plants provide secondary (biological) treatment
- 0.99 billion m3 wastewater is being secondary (biologically) treated

Turkish Wastewater Statistics -2

- 9 advanced-nutrient treating (BNR) plants in operation
- the BNR plants produce effluents compliant with the 91-EU Directive
- a total of 0.208 billion m3 wastewater is advanced treated per year
- 14 Plants are extended aeration plants; the *likelyhood of bacteria removals should be high in these*
- A total of 0.103 billion m3 watewater is being treated in extended aeration plants per year
- 3 Plants are trickling filters; treating 0.089 billion m3 / year. *Presumably these plants also provide higher bacteria removals*
- Remaining 52 plants are mostly conventional activated sludge plants and few are aerated lagoons.

Distribution of the Wastewater Treatment Plants in Turkey



Extended Aeration Plants	Location	Wastewater treated m3/y
Antalya	Antalya-Hurma	12 045 000
Antalya	Kemer-Beldibi	3 468 960
Antalya	Kemer-Camyuva	4 162 460
Antalya	Kemer-Goynuk	3 279 525
Antalya	Kemer-Kemer	3 721 175
Antalya	Kemer-Tekirova	2 112 620
Balıkesir	Edremit - Altinoluk (Yaz)	1 460 000
Balıkesir	Edremit - Altinoluk (Yaz)	1 460 000
Bursa	Inegol	23 360 000
İçel	Tarsus	7 700 588
İsparta	Merkez	2 522 280
İstanbul	Silivri-Silivri	485 450
Muğla	Dalaman	1 095 000
Sakarya	Sakarya	36 500 000
	TOTAL	103 373 058

Advanced (BNR) Treatment Plants	Place	**Wastewater m3/y**
Antalya	Hurma	12.045.000
Hatay	İskenderun	10.950.000
İstanbul	Terkos	620.500
İstanbul	Paşaköy	13.790.065
Izmir	Merkez	144.740.240
Izmir	Guneybatı	7.884.000
Kayseri	Kayseri	40150 000
Kocaeli	Kullar	7.665.000
Antalya	Alanya	10950000
	TOTAL	**208.644.805**

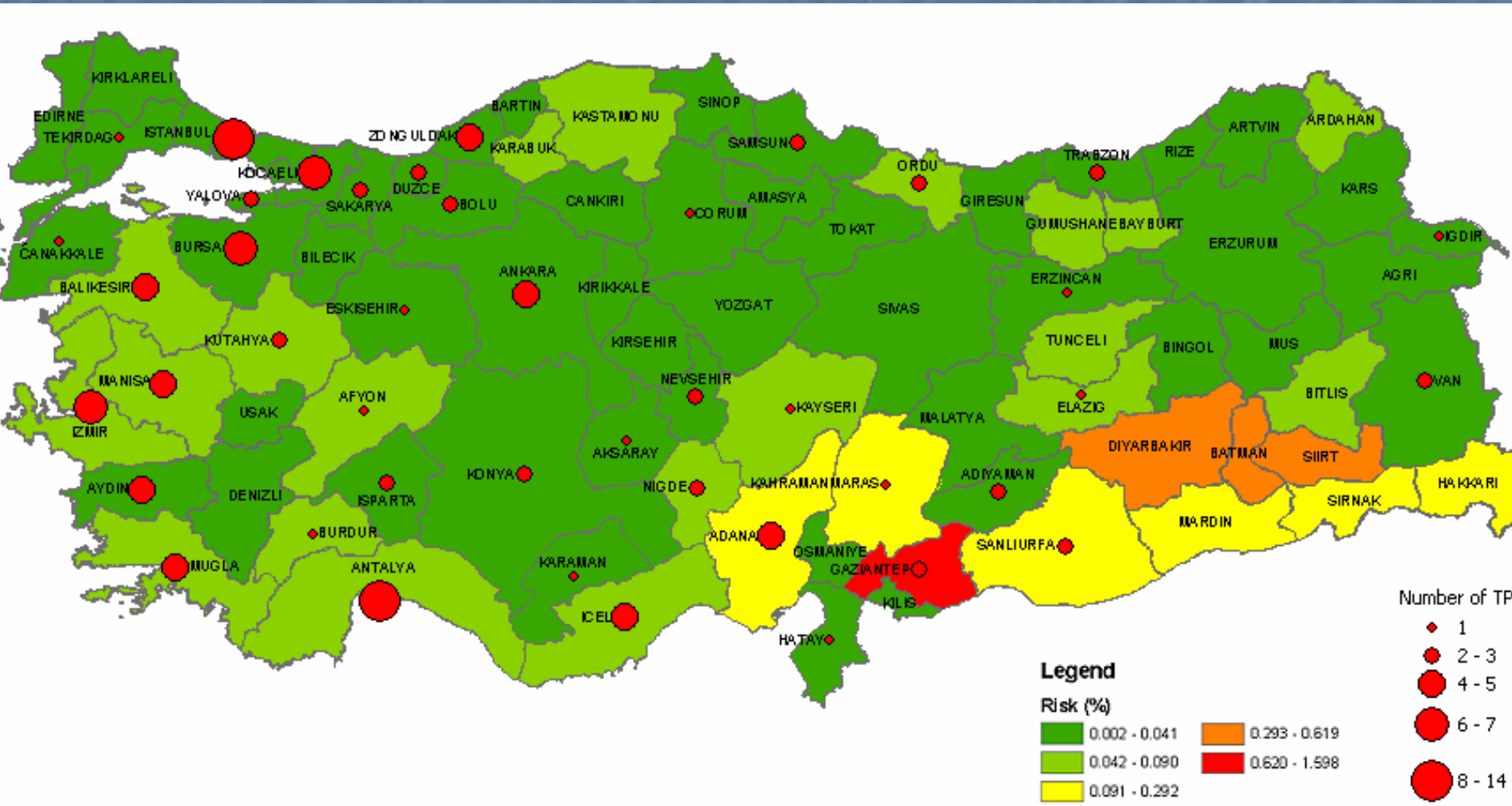
TRICKLING FİLTERS	LOCATION	Wastewater m3/y
Çanakkale	Ezine	98 550
Manisa	Alasehir	1 024 920
Düzce	Merkez-Duzce	87 600 000
	TOTAL	**88 723 470**

Reuse of Treated Wastewaters in Central, Eastern, SouthEastern, Western Blacksea and Mediterranean Regions in Turkey

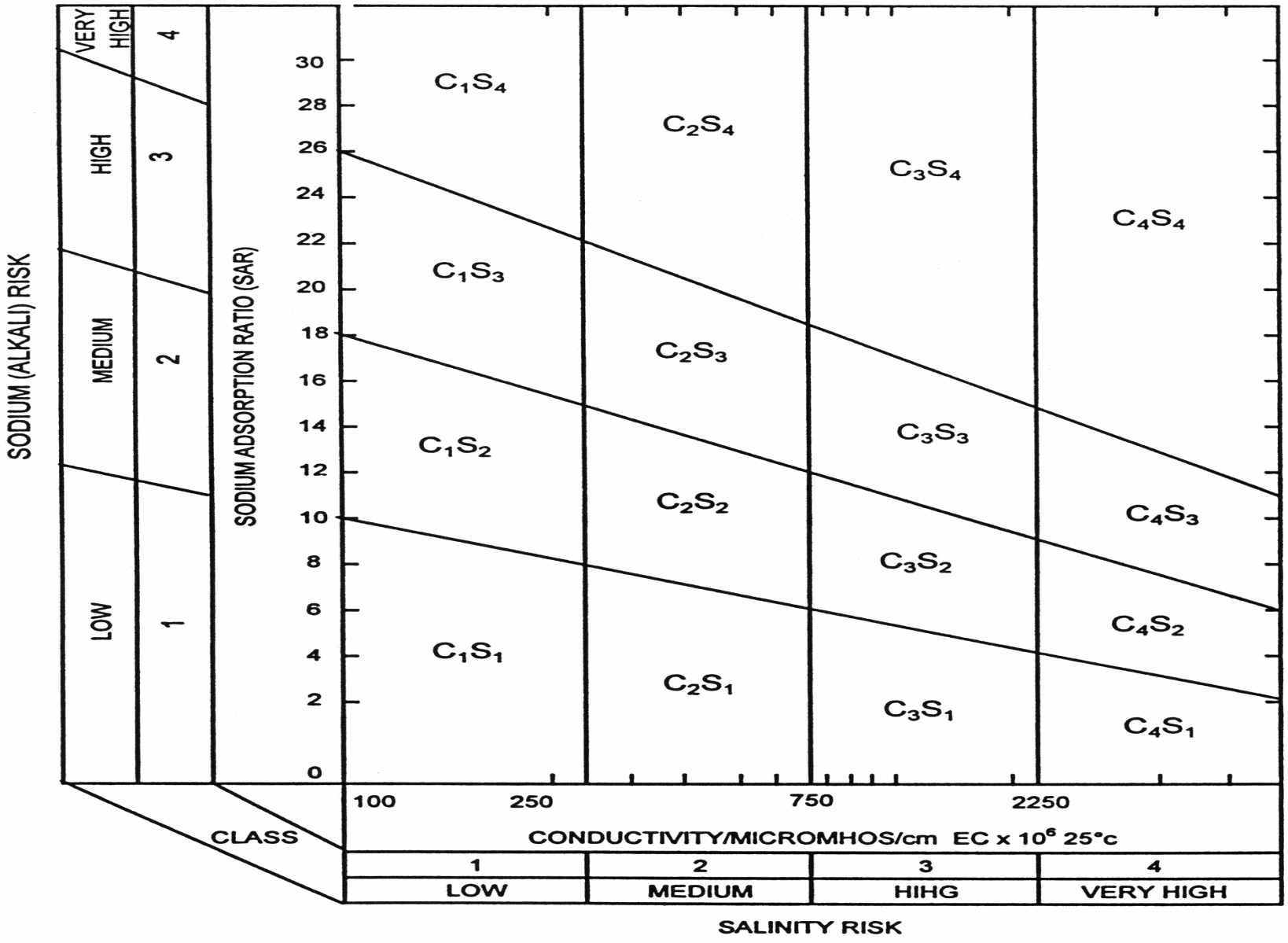
Province	Place	Name of plant	m3/a	Receiving environ.	Irrigation status
ksaray (Primary t.)	Merkez	Aksaray Municipality WWTP	9 125 000	Karasu Stream	INDIRECT *
nkara	-	ASKI, Ankara Municipal. WWTP	192 695 545	Ankara Creek	INDIRECT *
skisehir ** #	-	ESKI, Municipality WWTP	24 820 000	Porsuk River	INDIRECT *
aziantep ** #	-	GASKI , Municipality WWTP	73 000 000	S. Creek	DIRECT
dır (aer. tabilization))	Merkez	Igdır Municipality WWTP	551 880	Aras River	DIRECT
ayseri #	-	Kayseri Municipality WWTP	32 850 000	Karasu River	INDIRECT *
dana	Kozan	Kozan Municipality WWTP	2 780 000	Kozan Creek	INDIRECT *
dana	Yumurtalık	Yumurtalık Municipality WWTP	48 000	Ayas Creek	INDIRECT *
onya	Ilgin	Ilgın Municipality WWTP	2 838 240	Bulasan River	INDIRECT *
evsehir	Urgup	Urgüp Municipality WWTP		Damsa Creek	INDIRECT *
mir #	Merkez	IZSU Municipality WWTP	182 500 000	Izmir Bay	DIRECT/Gedi Plane

WWTP: Wastewater Tr. Plant.; * INDIRECT: Treated wwtrs are given to a river, from where the are drawn for use in irrigation; ** GASKI WWTP serves to irrigate 80 000 ha and ESKI wwtrs for 50 000 ha of land. # Irrigation projects are underway by SHW. *Smaller plants*, Konya-Kadınhani and Nigde-Bor, wwtrs are directly being used for irrigation (total of 5000 ha)

Occurance of Water-borne Diseases in Turkey



Turkish Water Reuse Standards in Crop Irrigation (Water Pollution Control Regulation, Technical Aspects Bulletin 1991) - 1



Turkish Water Reuse Standards in Crop Irrigation (Water Pollution Control Regulation, Technical Aspects Bulletin 1991) - 2

Quality Criteria	Irrigation Water Class				
	Class I (very good)	Class II (good)	Class III (usable)	Class IV (usable with caution)	Class V (detrimental. unusable
EC25 *10^6	0–250	250–750	750–2000	2000-3000	>3000
Variable Sodium Percentage, % Na	<20	20–40	40–60	60–80	>80
Sodium Adsorption Ratio (SAR)	<10	10–18	18–26	>26	
Sodium Carbonate Residue (RSC), meq/l	>1.25	1.25–2.5	>2.5		
Ditto mg/l	<66	66–133	>133		
Cl^-, meq/l mg/l	0–4 0–142	4–7 142–249	7–12 249–426	12–20 426–710	>20 >710
SO_4^{-2}, meq/l mg/l	0–4 0–192	4–7 192–336	7–12 336–575	12–20 575–960	>20 >960
Total Salts, mg/l	0–175	175–525	525–1400	1400-2100	>2100

Turkish Water Reuse Standards in Crop Irrigation (Water Pollution Control Regulation, Technical Aspects Bulletin 1991) - 3

Quality Criteria	Irrigation Water Class				
	Class I (very good)	Class II (good)	Class III (usable)	Class IV (usable with caution)	Class V detrimental unusable)
Boron, mg/l	0–0.5	0.5–1.12	1.12–2	>2	
Irrigation Water Class	C_1S_1	C_1S_2. C_2S_2. C_2S_1	C_1S_3.C_2S_3. C_3S_3.C_3S_2. C_3S_1	C_1S_4.C_2S_4. C_3S_4.C_4S_4. C_4S_3.C_4S_2. C_4S_1	
NO_3^- or NH_4^+, mg/l	0–5	5–10	10–30	30–50	>50
Fecal Coliforms, /100ml	0–2	2–20	20–100	100–1000	>1000
BOD_5, mg/l	0–25	25–50	50–100	100–200	>200
Suspended Solids, mg/l	20	30	45	60	>100
pH	6.6–8.5	6.5–8.5	6.5–8.5	6.5–9	<6 or >9
Temperature	30	30	35	40	>40

Microbiological Irrigation Water Qulity Guidelines for Treated Wastewaters - 1

- *Title 22:* US Technology based standard. The strictest. Zero F. coli/L
- WHO Guideline: Pragmatic approach. The FC<1000 /100 mL and < 2 NTU is based on bathing water quality criteria
- Most recent is the Australian standard, also adopted by Japan and S. Africa. Calls for 100-200 FC/ 100 mL for unrestricted crop irrigation.

Microbiological Irrigation Water Qulity Guidelines for Treated Wastewaters - 2

- *Blumenthal et. al. 2000*. Guideline developed for the Mediterranean states considering risk assessment for the region and modelling studies.
- Supposed to be optimum for the Mediterranean states considering their cultural, economic and social characteristics.

Guidelines Developed for the Mediterranean States for Wastewater Reuse in Irrigation

Blumenthal et. al. (2000) - 1

Water category	Quality criteria: Microbiological: Intestinal nematode[a] (no. eggs per liter)	Quality criteria: Microbiological: FC or *E. coli*[b] (cfu/100 mL)	Physical-chemical SS[c] (mg/L)	Wastewater treatment expected to meet the criteria
Category I				
a) Residential reuse b) Urban reuse c) Landscape and recreational impoundments (contact is allowed)	≤ 0.1[h]	≤ 200[d]	≤ 10	Secondary treatment + filtration + disinfection
Category II				
a) Irrigation of vegetables b) Landscape impoundments (contact is not allowed)	≤ 0.1[h]			Secondary treatment or equivalent[g] – filtration + disinfection
				or
c) Industrial reuse (except for food industry).	-	≤ 1000[d]	≤ 20 ≤ 150[f]	Secondary treatment or equivalent[g] + either storage or well-designed series of maturation ponds or infiltration percolation
Category III				
Irrigation of cereals and oleaginous seeds, fiber, & seed crops, dry fodder, green fodder without direct grazing, crops for canning industry, industrial crops, fruit trees (except sprinkler-irrigated)[e], plant nurseries, ornamental nurseries, wooden areas, green	≤ 1	None required	≤ 35 ≤ 150[f]	Secondary treatment or equivalent[g] + a few days storage or Oxidation pond system

uidelines Developed for the Mediterranean States for Wastewater Reuse in Irrigation
Blumenthal et. al. (2000) - 2

ategory IV				
) Irrigation of vegetables guaranteeing bsence of contact between reclaimed ater and edible part of vegetables.) Irrigation of crops in category III with rip irrigation (such as drip, bubbler, icro-sprinkler and subsurface). Irrigation with surface with drip rigation of greenbelts and green areas ith no access to the public.) Irrigation of parks, golf courses, sport elds with sub-surface irrigation systems.	None required	None required		Pretreatment as required by the irrigation technology, but not less than primary sedimentation
ategory V				
roundwater recharge:				
) Surface spreading into non-potable quifers	-	None required	≤ 35	Secondary treatment or equivalent (g)
) Surface spreading into potable aquifers	-	≤ 1000(d)	≤ 20	Secondary treatment or equivalent (g) + filtration + disinfection Advanced

ource: Blumenthal, U. J., Mara, D. D., Peasey, A., Ruiz-Palacios, G. and Scott, R., 000. Guidelines for the microbiological quality of treated wastewater used in griculture: recommendations for revising WHO guidelines. *Bulletin of the WHO* Vol.**78**

Israeli Irrigation Water Quality Standards for Wastewater Reuse

rameters	Group of crops/main crops			
	A Cotton, sugar beet, cereals, dry fodder seeds, forest irrigation, etc.	B Green fodder, olives, peanuts, citrus, bananas, almonds, nuts, etc.	C Deciduous fruits[b] conserved vegetables, cooked and peeled vegetables, green belts, football fields and golf courses	D Unrestricted crops including vegetable eaten uncooked (raw parks and lawns
fluent quality				
OD_5 total (mg/l)	60[a]	45[a]	35	15
OD_5 dissolved (mg/l)	–	–	20	10
spended solids (mg/l)	50[a]	40[a]	30	15
ssolved oxygen (mg/l)	0.5	0.5	0.5	0.5
liforms counts (/100 ml)	–	–	250	12 (80%) 2.2 (50%)
sid. avail. chlorine (mg/l)	–		0.15	0.5
andatory treatment				
nd filtration or uivalent	–		–	required
lorination (minimum ntact time, min)	–		60	120
stances				
om residential areas (m)	300	250	–	–
om paved road (m)	30	25	–	–

ifferent standards will be set for stabilization ponds with retention time of at least 15 days.[b]Irrigation must stop 2 weeks before fr
cking; no fruit should be picked from the ground.

Conformity of Selected Treatment Plant Effluents to Current Reuse Guidelines in the Central, Eastern, Southeastern, Western Black Sea and Mediterranean Regions in Turkey

- No bacteriological or parasitological data available on any of these plants, therefore classification is only provisional and based on the available data
- None of the plants process filtration and disinfection processes following secondary treatment
- On the following conformity table parameters in parenthesis indicate non-compliant single parameters
- Following abbreviations are used in the following table to indicate process trains:

  1= coarse screen 2=fine screen 3=shredder 4=grid trap 5=primary sedim. 6=trickling filter 7=aeration tank 8=secondary clarifier 9=aerated lagoon 10=oxidation ditch 11=disinfection 12=other (anaerobic + anoxic tanks for nutrient removal)**

Conformity of the selected plants to Turkish and Israeli standards and to the Mediterranean Guideline - 1

WWTP NameS	Proces *	SS mg/L	SS Class	Classification	
			Mediterranen guideline	Israeli Std.	Turkish Std***
SKI, Ankara Central WWTP	1+2+4+5+7+8	15	2	A, B	I-III(N
lanya Central WWTP	1+2+4+7+8+11+ 12**	8	1	A, B	I
ntalya Hurma WWTP	1+2+4+7+8+9+ 11+12**	10	1	A, B	I-II(N)
lazig Municipality WWTP	1+2+4+5+7+8+ 12	16	2	A, B	I-II(BOD
rzincan Municipality WWTP	2+4+7+8	15	2	A	I-III (BOD_5

onformity of the selected plants to Turkish and Israeli standards and to lediterranean Guideline -2

WWTP NameS	Proces *	SS mg/L	SS Class	Classification	
			Mediterranen guideline	Israeli Std.	Turkish Std****
ESKI WWTP	1+2+4+5+7+8	12	2	A, B	I-III (N)
GASKİ WWTP	1+2+4+5+7+8	15	2	A, B	I
Nizip Municipality WWTP ***	1+2+4+5+7+8	174	none	NONE	IV-V
Iskenderun Municipality WWTP	1+2+4+5+7+8+12 **	15	2	A, B	I
Isparta Municipality WWTP	1+2+4+5+7+8	25	3	A, B	I
Kayseri WWTP	1+2+4+5+7+8+12 **	10	1	A, B	I-III (EC)
Kadınhanı Municipality WWTP	5+12	48	none	A	I-III (SS)
Tarsus Municipality WWTP	1+2+4+7+8	3	1	A, B	I-III (EC)
Sarıköprü WWTP	1+2+4+5+7+8+12	20	2	A, B	I

Agricultural Statistics in Turkey

- *Based on 2001 General Agricultural Questionnaire (GTS)*
- Total available land is 66.88 million hectars (ha)
- Total arable land 22.16 Mi ha (%33)
- 22.78 % of arable land currently not irrigated
- 2.91 % of arable land is left uncultivated
- Only 0.88 % of arable land is being
- 5.6 % land is left uncultivated each year to restore nutrients
- Of the 37472 farming units questioned only 13.24 % responded having adequate water supplies for irrigation

CONCLUSIONS - 1

- A large fraction of the population is connected to treatment plants (30 %) in Turkey. However this mainly corresponds to the population in cities.
- In the case of rural settlements very few are connected to treatment plants. Indicating the need for decentralized, small-scale reuse facilities.
- The microbiological standards stipulated by the 'Technical Aspects Bulletin' for wastewater reuse in Turkey, is unrealistically stringent and ought to be updated in the light of the current scientific evidence. For example the proposed guidelines for the Mediterranean countries may be adopted, which will also ensure homogeneity in practice between the neighboring states in the region.
- Values for Nitrogen salts, as they appear in the current reuse standard, does not differentiate between NH_4^+ and NO_3^- salts. For reuse purposes this should be expressed as NH_4^+ to protect the groundwater and for maximum residence of N salts in the root zone.

CONCLUSIONS - 2

- For proper reuse of treated wastewaters in Turkey it is essential that treatment efficiencies of WWTPs should be under constant surveillance.
- Critical microbiological and parasitological parameters should be included in the standard and be regularly monitored in the effluents
- Additional technology standards should be adopted for added filtration and disinfection of secondary treated wastewaters

CONCLUSIONS - 3

- As a result of extensive reuse practices in the Mid- and Southeast Anatolia nearly 1 billion m^3/year additional resource for irrigation will be created
- Additional crop production and economic growth is possible
- Better prevention of pollution of lakes, seas and rivers will be possible. Sustainable growth and compliance with the EU standards will be possible.

CONCLUSIONS - 4

- Assuming 500 mm water is required for single harvest of corn and 2.0 tons will be produced per hectare and that selling price for a ton of corn is around 267 US$, this represents 125 Million USD/year additional revenue for the region. With the added values this may quadruple and may rise over one million USD and creating new jobs.
- Same is true for wheat.
- Reuse practice should also create a means for auto-controlling of pollutant discharges in a sector where tight control is not currently being practiced. This will be achieved by creating two opposing beneficiary groups whose interaction will ensure better and continued compliance with the discharge standards

THANK YOU FOR LISTENING

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