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MEDAWARE Project

- 'Development of Tools and Guidelines for the Promotion of the Sustainable Urban Wastewater Treatment and Reuse in the Agricultural Production in the Mediterranean Countries'

MEDAWARE Participating Countries

1. Cyprus	Nicosia	Agriculture Research Institute
2. Jordan	Irbid	Jordan University of Sciences and Technology
3. Lebanon	Beirut	American University of Beirut
4. Marocco	El Jadida	Chouaib Doukkali University,
5. Palestinian Authority	Gaza	Ministry of Environmental Affairs
6. Türkiye	Ankara	ODTÜ
7. Türkiye	Istanbul	İTÜ
8. Greece	Athens	National Tech. Univ. of Athens
9. Greece	Chania-Grete	Prospect Systems Env. Protection Tech, & Systems
10. Spain	Boecillo	Cartif, Centro de Automatimazion, Robotica y Technologias

Medaware Project Main Objectives

- Duration 42 months
- 1.84 million € budget
- Total of 8 work packages
- Protection of water resources
- Sustainable utillization of urban water resources
- Use of urban wastewters in irrigation
- To reduce water pollution from urban sources to the minimum

Issues to be tackled and targets aimed

- Uncontrolled crop irrigation by urban wastewaters and related health issues.
- Evaluate irrigation water quality standards and criteria and update these according to the most recent trends
- Inadequate treatment of urban wastewaters.
- Explore the avalibility of qualified personnel in WWTP operations
- Revise and evaluate reuse technologies
- Study successful examples of re-use implementation.
- Know-how transfer and dissemination

Timing of Workpackages

Work package	Start		End	
1	1	(May 03)	6	(Oct 03)
2	5	(Sept 03)	10	(Feb 04)
3	7	(Nov 03)	11	(Mar 04)
4	11	(Mar 04)	21	(Jan 05)
5	21	(Jan 05)	26	(June 05)
6	26	(June 05)	30	(Oct 05)
7	31	(Nov 05)	42	(Oct 06)
8	Management			

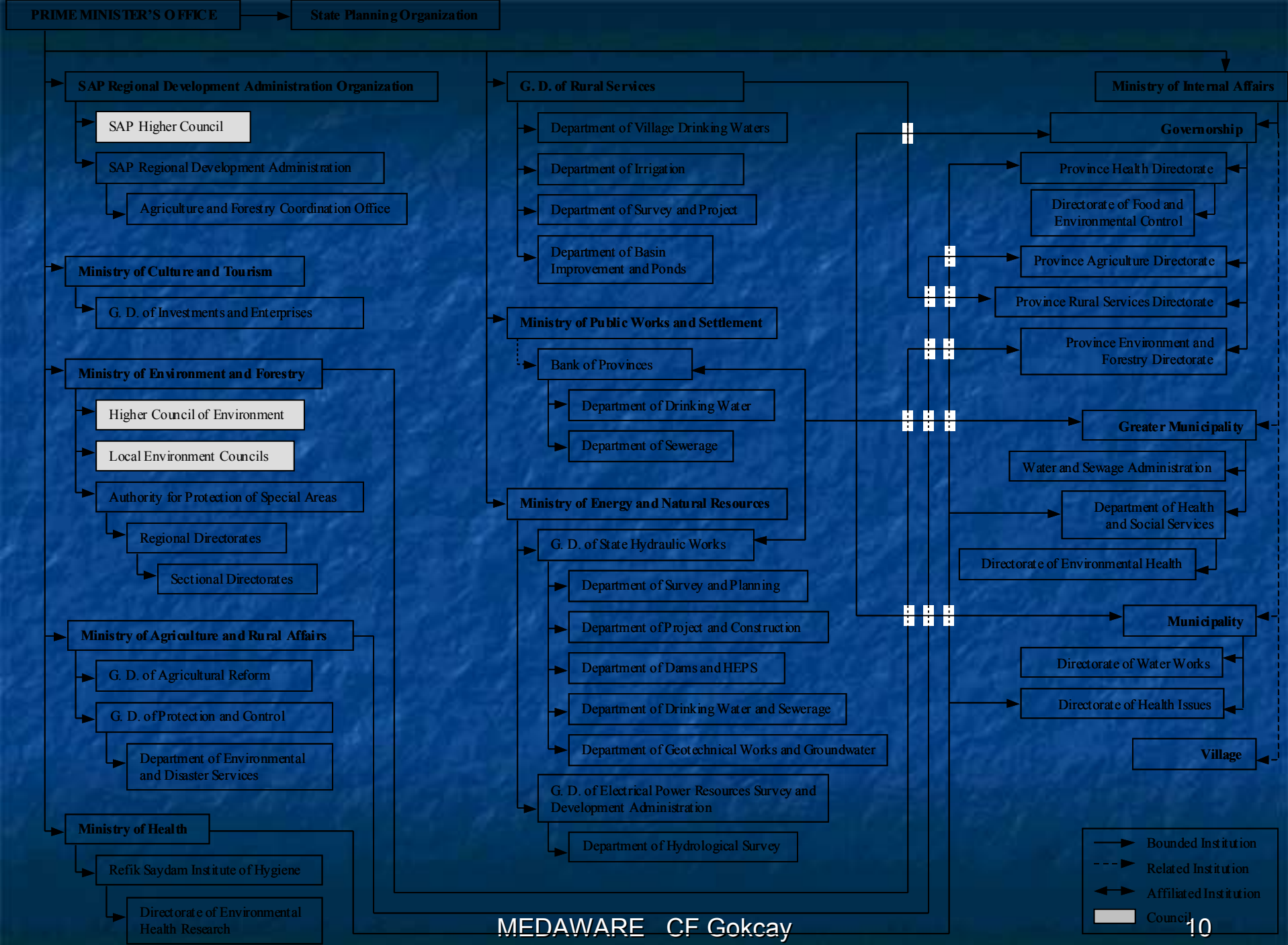
Outline of Work Packages - 1

1	Country profiles: Actors, managerial organization tree, legislations, socioeconomical instruments
2	Present situation: Inventory of the Current WWTPs, technology, reuse options, EU compatibility
3	Success stories: Study of successful reuse applications, identification and transfer of fundamental design criteria to partners
4	Technology: Study innovative, fore-front reuse technologies, their applicability to individual countries, preparation of specs.

Outline of Work Packages - 2

5	Development of specs for the proper reuse of wastewaters in agriculture
6	Developing methodology and data base for the monitoring and control of WWTP and wastewaters
7	Developing a multicriteria sofware to provide necessary information to end-user as to provide necssary information on reuse of wastewaters in agriculture

Profile of Turkey and Summary of Institutional Framework Regarding the Environment


PRIME MINISTER'S OFFICE
State Planning Organization
SAP Regional Development Administration Organization
SAP Higher Council
SAP Regional Development Administration
Agriculture and Forestry Coordination Office
Ministry of Culture and Tourism
G. D. of Investments and Enterprises
Ministry of Environment and Forestry
Higher Council of Environment
Local Environment Councils
Authority for Protection of Special Areas
Regional Directorates
Sectional Directorates
Ministry of Agriculture and Rural Affairs
G. D. of Agricultural Reform
G. D. of Protection and Control
Department of Environmental and Disaster Services
Ministry of Health
Refik Saydam Institute of Hygiene
Directorate of Environmental Health Research
G. D. of Rural Services
Department of Village Drinking Waters
Department of Irrigation
Department of Survey and Project
Department of Basin Improvement and Ponds
Ministry of Public Works and Settlement
Bank of Provinces
Department of Drinking Water
Department of Sewerage
Ministry of Energy and Natural Resources
G. D. of State Hydraulic Works
Department of Survey and Planning
Department of Project and Construction
Department of Dams and HEPS
Department of Drinking Water and Sewerage
Department of Geotechnical Works and Groundwater
G. D. of Electrical Power Resources Survey and Development Administration
Department of Hydrological Survey
Ministry of Internal Affairs
Governorship
Province Health Directorate
Directorate of Food and Environmental Control
Province Agriculture Directorate
Province Rural Services Directorate
Province Environment and Forestry Directorate
Greater Municipality
Water and Sewage Administration
Department of Health and Social Services
Directorate of Environmental Health
Municipality
Directorate of Water Works
Directorate of Health Issues
Village
Bounded Institution
Related Institution
Affiliated Institution
Council

Laws and Regulations Pertaining to Wastewater Treatment, Disposal and Reuse

Year	Establishment	Law/Regulation/Bulletin
1983	MoEF	Environment Law
1988	MoEF	Water Pollution Control Regulation (WPCR)
1989	MoEF	WPCR Administration Aspects Bulletin
1989	MoEF	WPCR Toxic and Hazardous Substances in Water Bulletin
1991	MoEF	WPCR Technical Aspects Bulletin
1995	MoARA	Aquatic Products Regulation
2001	MoEF	Environmental Inspection Regulation
2002	MoEF	Environmental Impact Assessment Regulation

MoEF: Min. Of Environment and Forestry, MoARA: Ministry of Agriculture and Rural Affairs

List of Actors Involved in Wastewater Treatment and Reuse- 1

Actor	PLANNING			SERVICE			FINANCE			MONITOR		
	V	S	I	V	S	I		S	I		S	I
Ministry of Environment and Forestry												
Authority for Protection of Special Areas												
Ministry of Health												
Ministry of Agriculture and Rural Affairs												
G.D. of Agricultural Reform												
Ministry of Internal Affairs												
Governorships												
Municipalities												
Ward Administration												
Ministry of Energy and Natural Resources												
G.D. of State Hydraulic Works												

List of Actors Involved in Wastewater Treatment and Reuse - 2

Actor	PLANNING			SERVICE			FINANCE			MONITOR		
	W	S	I	W	S	I	W	S	I	W	S	I
G. D. of Electrical Power Resources Survey and Development Administration	■			■						■		
Prime Minister's Office	■	■	■									
State Planning Organization	■	■	■				■	■	■			
G. D. of Rural Services	■	■	■	■	■	■						
SAP Reg. Development Administration	■	■	■	■	■	■	■	■	■			
Ministry of Public Works and Settlement												
Bank of Provinces	■	■	■	■	■	■	■	■	■			
Ministry of Culture and Tourism				■	■		■	■				

W: Water, S: Sewage (Wastewater), I: Irrigation

Water Potential

- Total annual water potential in the country is around 187 Billion m3
- 30-35 Billion m3 used directly in irrigation
- Around 5-6 billion m3 is being used for domestic purposes
- Although ample water potential exist, availibility is not homegenously distributed. Local water shortages and at times of crisis should be overcome by reusing treated wastewaters.

Water Withdrawal in Turkey (DSI-2001)

	Rural Withdrawal distribution (%) (Total water amount: 164 x 10^6 m^3)	Urban Withdrawal distribution (%) (Total water amount: 6202 x 10^6 m^3)
Spring water	24.3	22.1
Lake	0.53	10.3
River	1.54	2.21
Dam	4.90	39.6
Groundwater	67.4	24.1
Pond	0.37	1.57
Other	0.96	0.12

The results of Water Table Observation Studies (DSI 2002)

Years	2001		2002	
Salinity Levels	Area (ha)	Rate (%)	Area (ha)	Rate (%)
0-2500	1127769	90	863035	86
2500-5000	91411	7	114399	11
5000-7500	23322	2	20551	2
7500-10000	10166	1	5992	1
10000<	6109	0	5214	1
Total	1258777	100	1009191	100
The ratio of observed area to total irrigtonal area (%)	68		53	


Area of Turkey
78 million ha
Agricultural Land
28 million ha
Forest,Meadows Bushes 23 mi. ha
Pasture and Grassland
22 million ha
Others
4 million ha
Water Surface Area 1 mi. ha
Agricultural Land
28 million ha
Area that can be irrigated
26 million ha (economically 8.5 million ha)
Area that can not be irrigated
2 million ha
Dry Agriculture
22.5 million ha
Wet agriculture
4.5 million ha
Special Plants
1 million ha
Fallow
16 million ha
No Fallow
6 million ha
RE CF G
Land (Slope 12%): 9 million ha
Land (Slope 6%): 17 million ha

Vegetable and Fruit production, 2000 (IES)

Crops	Production
Field crops	63 433 032 tons
Cereals	32097114 tons
Vegetable	22 357 612 tons
Fruit	14 179 138 tons

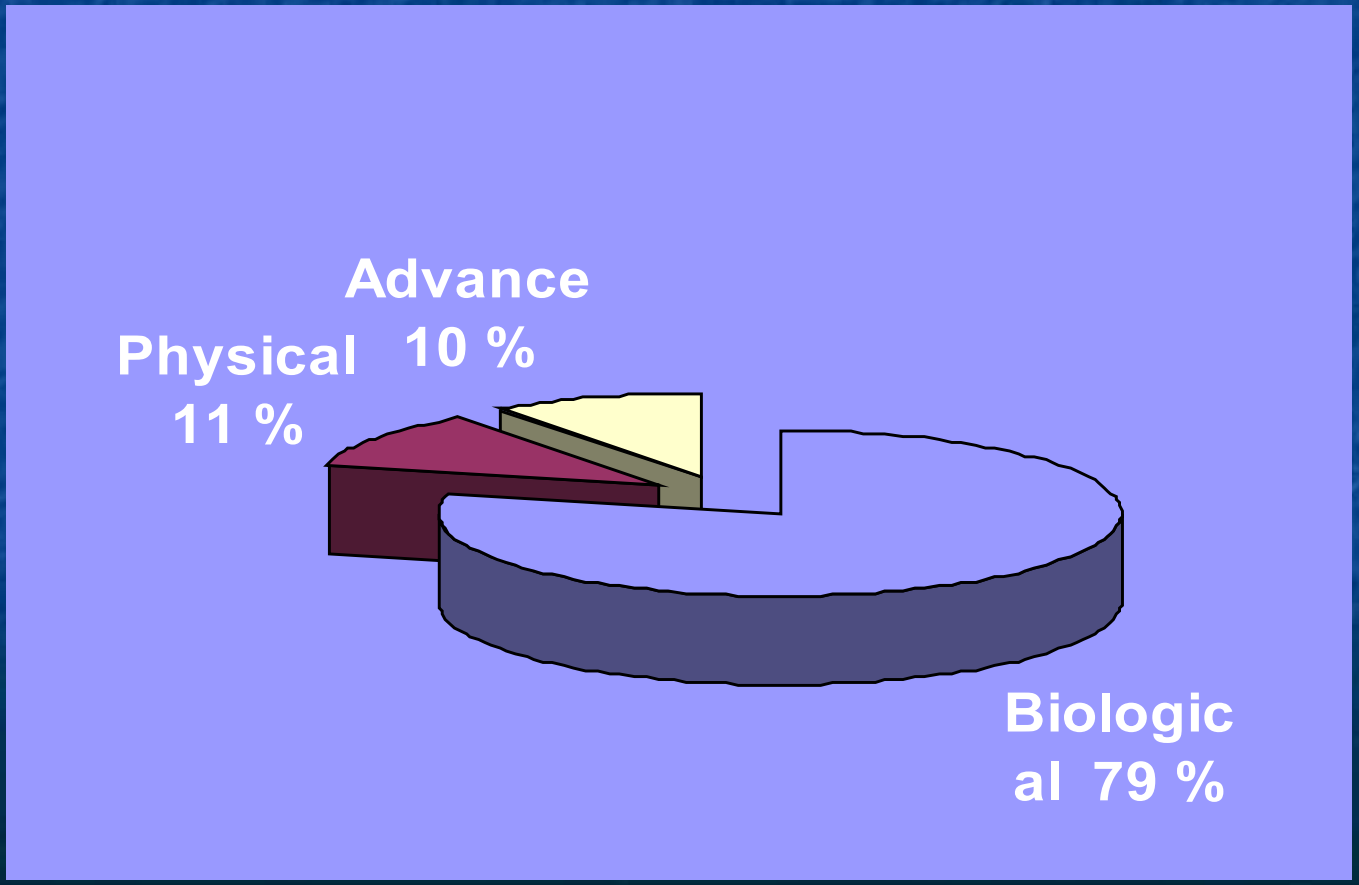
Based on 2001 General Agricultural Questionnaire (GTS)

- Of the 37472 farming units questioned only 13.24 % responded having adequate water supplies for irrigation
- Although ample water potential exist, availibility is not homegenously distributed. Local and seasonal water shortages and times of draught should be overcome by reusing treated wastewaters.

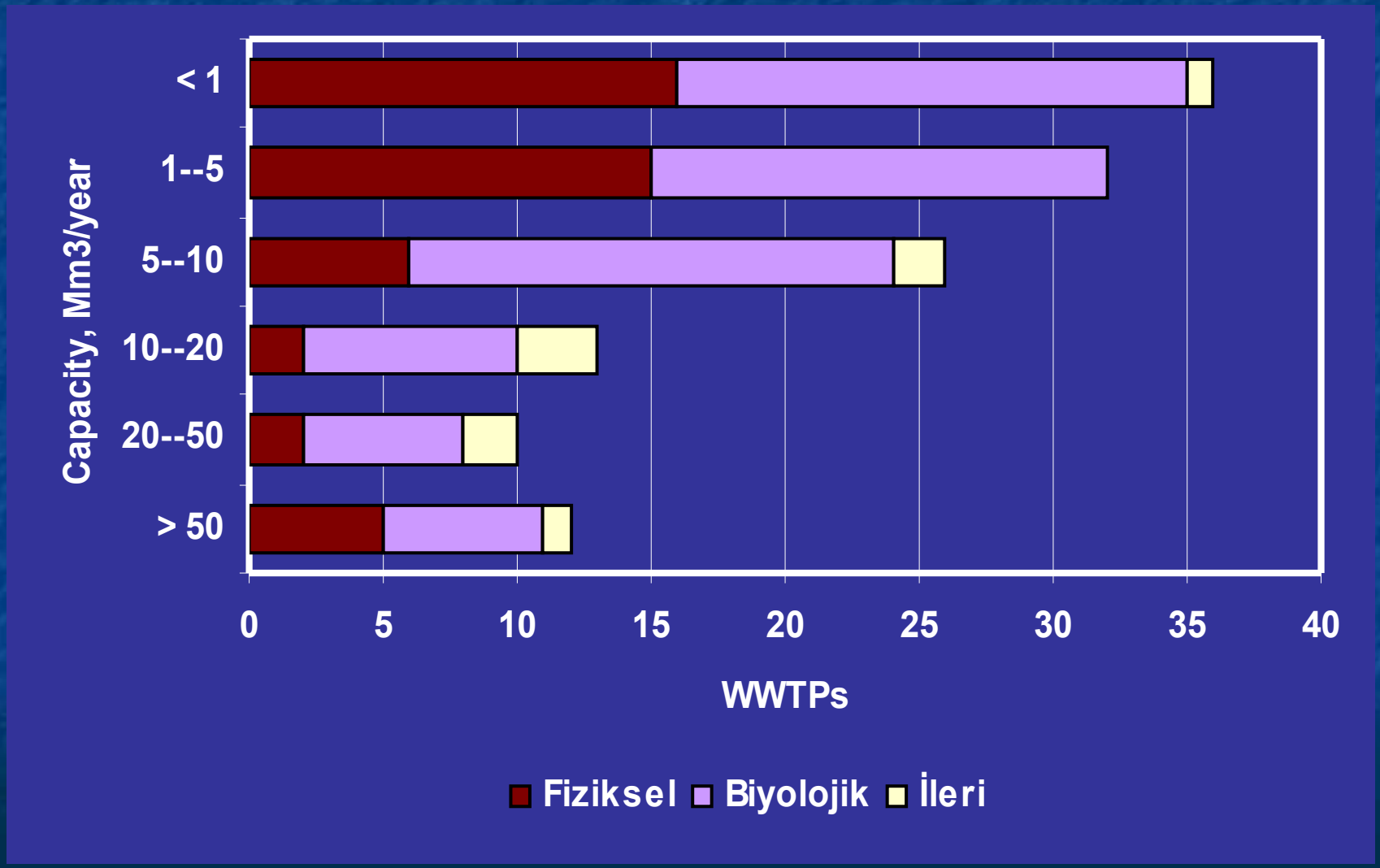
Present situation: Inventory of the Current WWTPs, technology, reuse options, EU compatibility

Treatment Technologies

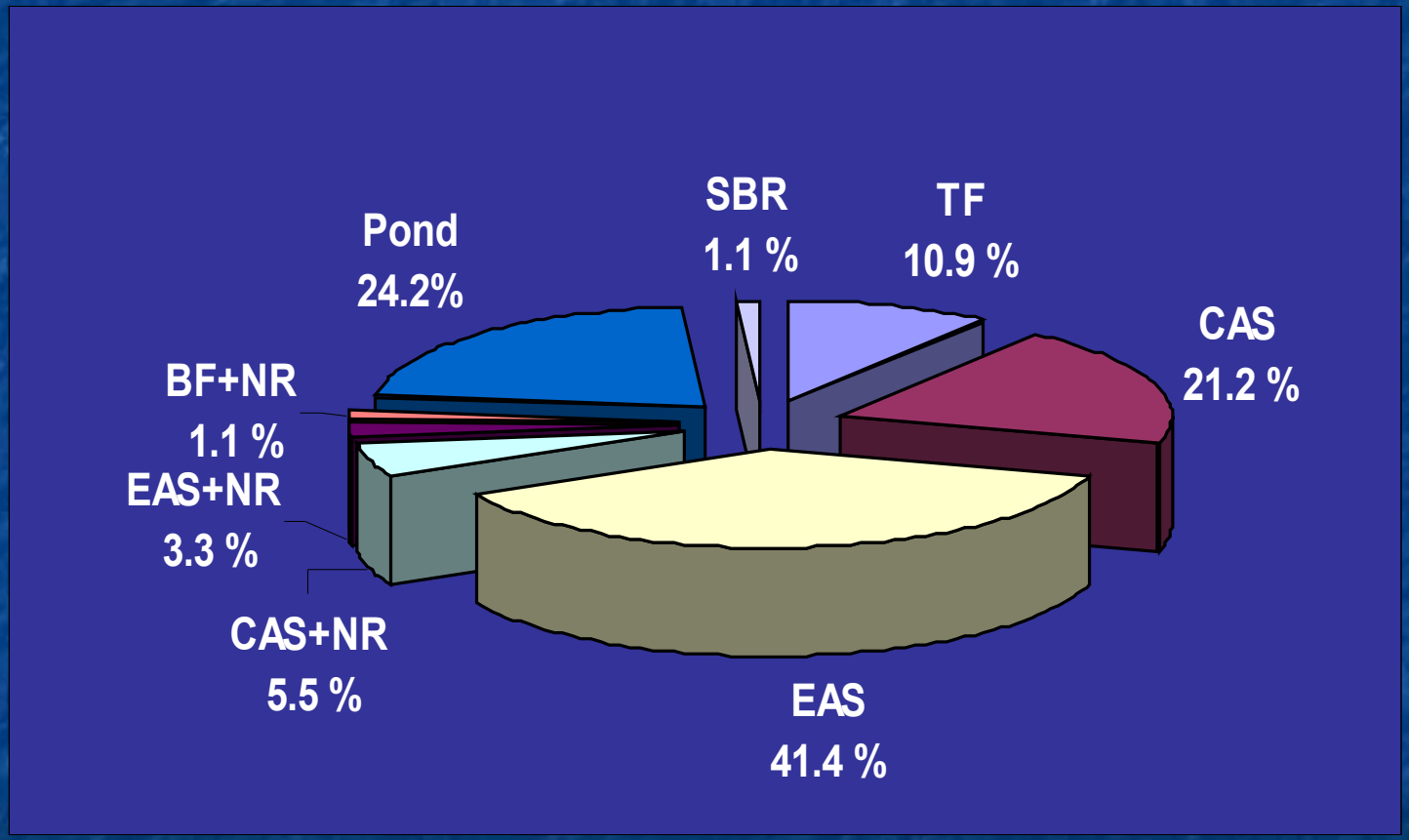
- Physical treatment (46 WWTP)
- Biological Treatment (74 WWTP)
- Advanced treatment (9 WWTP)



Capacity Distribution of WWTPs

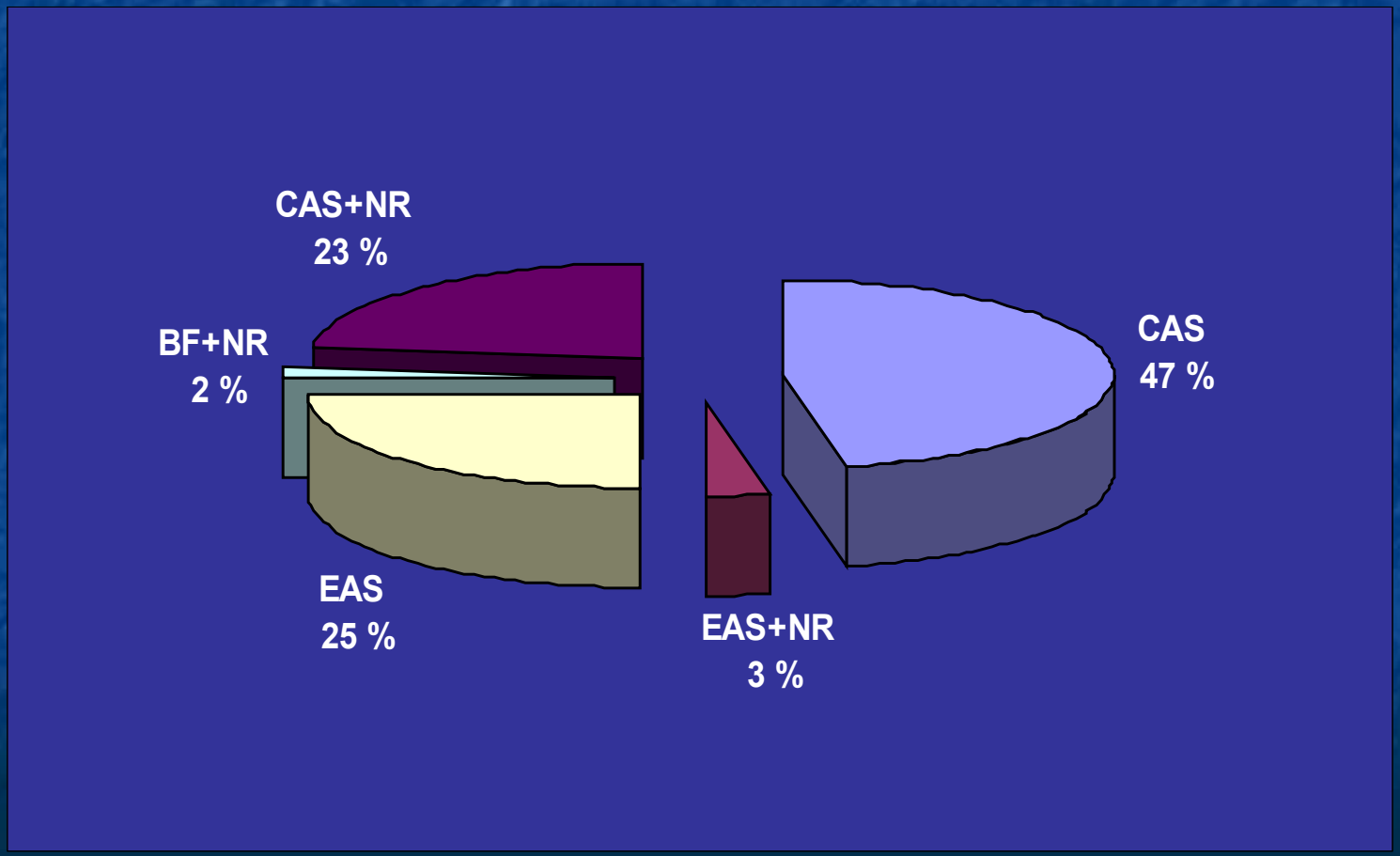


Disitribution of Biological Technologies in Numbers



CAS: Conventional Act. Sludge; EAS: Extended Aeration Act. Slu; TF: Trickling Filter.; BF: Biyological filters.; NR: Nutrient treatment.; SBR:Sequencing Batch reactor

Disitribution of Biological Technologies on the bases of Flow of Wastewater Treated



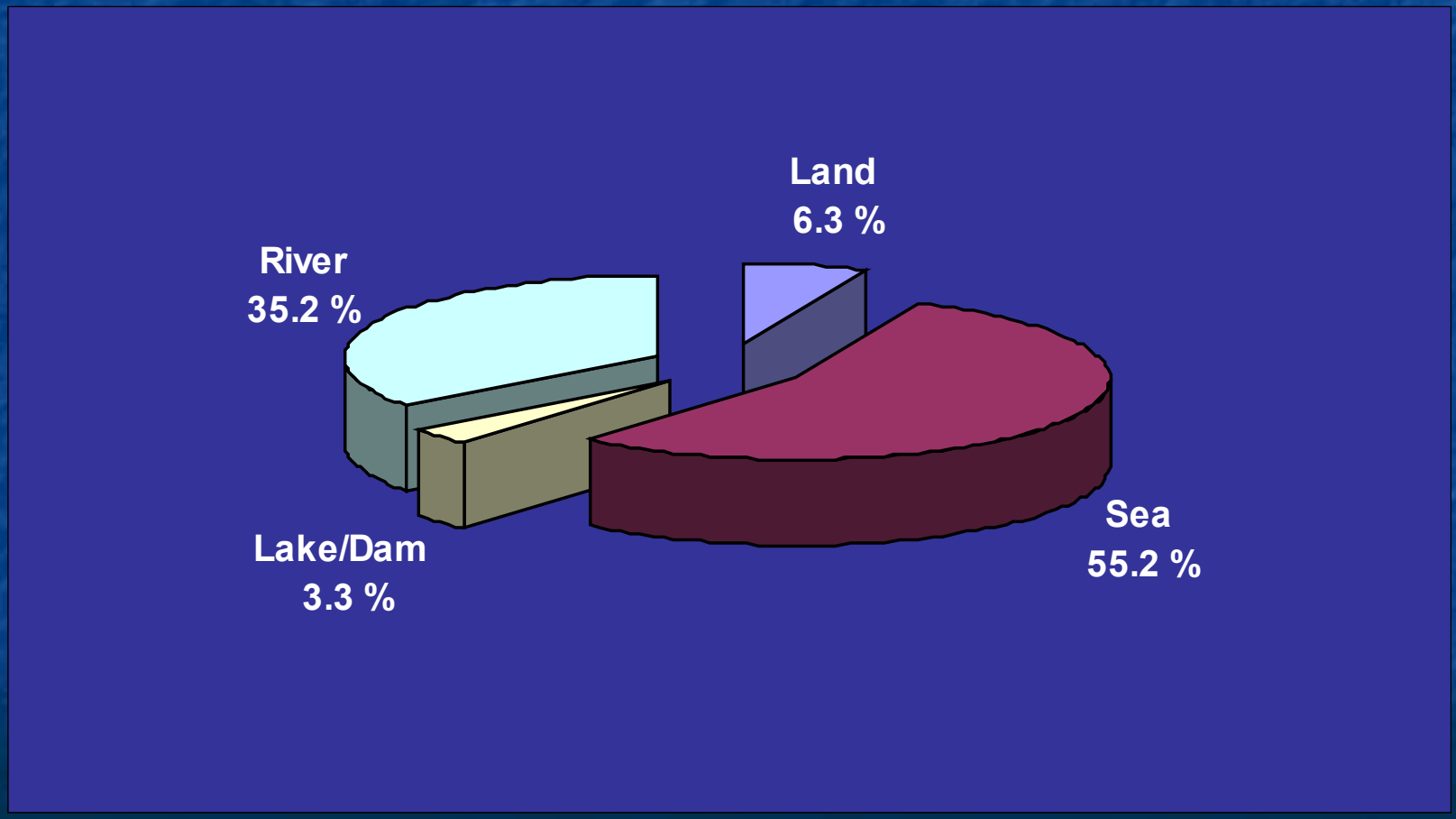
Example of the WWTP Inventory Displayed in the 1 st Report. Every entry includes the process train, influent and quality values, as well as the below information.

WWTP Code	*Discharge flow (m^3/ year)*	*Effluent quality*			
		COD mg/l	*BOİD$_5$ mg/l*	*SS mg/l*	*pH*
TR-01-01	25.550.000	188	127	47	7,9
TR-06-01	192.695.550	44	9	15	NA
TR-06-02	6.307.200	49	9	8	7,8
TR-07-01	16.425.000	26	9	10	7,8
TR-07-02	16.425.000	25	10	8	6,5
TR-07-03	3.468.960	25	4	10	7,6
TR-07-04	4.162.460	32	7	11	7,4
TR-07-06	3.721.180	35	8	11	7,8
TR-07-07	2.112.620	52	11	13,5	7,4
TR-07-11	8.030.000	40	15	6	6,0

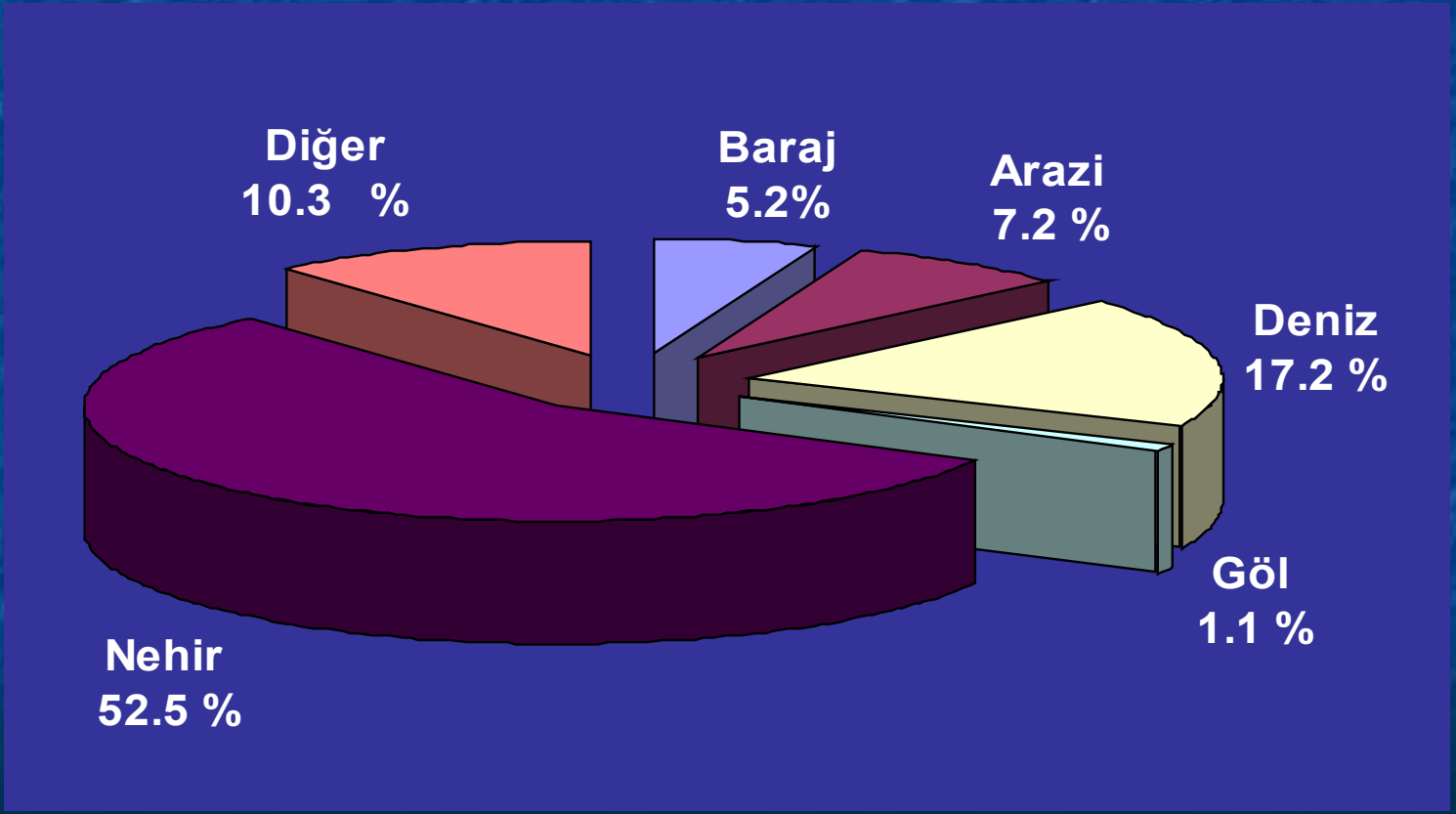
Entries also include per cent industrial input to individual domestic discharges; as shown in below example

Province	*Municipality*	*Industrial input (%)*
Ankara	Ankara	10
Aydin	Nazilli	10
Balikesir	Burhaniye	None
Elazig	Elazig	10
Eskisehir	Eskisehir	4.4
Gaziantep	Gaziantep	5
Gaziantep	Nizip	15 – 20
Isparta	Isparta	None
Istanbul	Tuzla	60 – 75
Kocaeli	Kocaeli – 42 Evler	56
Kutahya	Kutahya	None

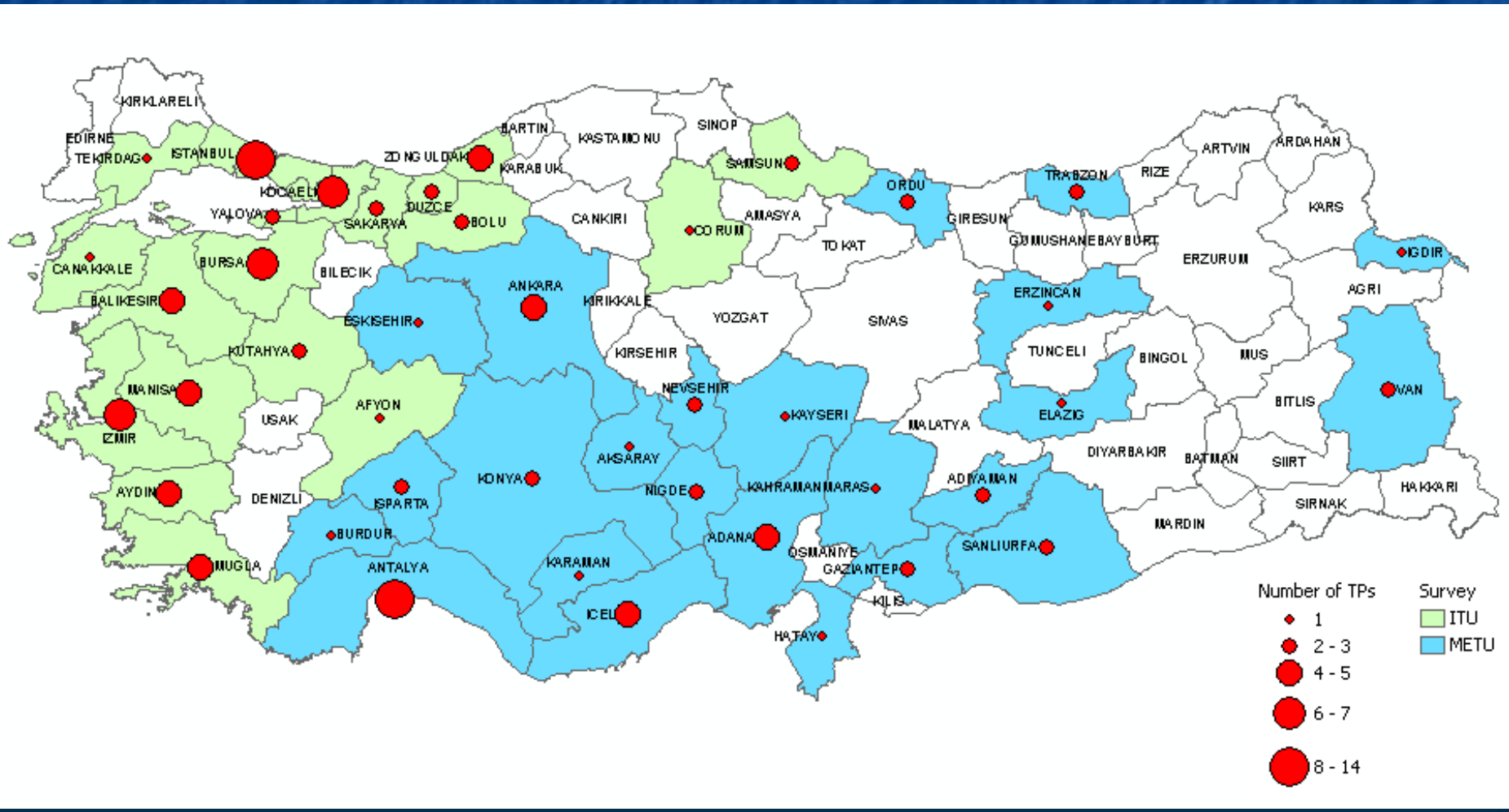
Percentage of Treated Waters being Discharged to Different Receiving Environs



Percentage of Untreated Waters being Discharged to Different Receiving Environs



Distribution of the Wastewater Treatment Plants in Turkey



Effect of WTTPs on the Receiving Environment-1

Name of WWTP	*ΣQ m^3/yıl*	*Comp liance*	***A-Rec. Envir***	*ΣQ of **A** m^3/yıl*	*Class* (upstream*	*Class (downst ream)*	***Effect***
Doğu Adana AAT	?	?	Seyhan	$6.2x10^6$	II	II	None
Aksaray Bel. AAT	$9x10^6$	?	Karasu	$5.3x10^6$	II	IV	Very high
ASKİ Ankara AAT	$192x10^6$	Yes	Ankara creek	?	IV	?	Already polluted

Compliance: Compliance to the current Turkish discharge standards

Effect of WTTPs on the Receiving Environment-2

Name of WWTP	*ΣQ m^3/yıl*	*Comp liance*	***A-Rec. Envir***	*ΣQ of **A** m^3/yıl*	*Class* (upstream*	*Class (downst ream)*	***Effect***
ESKİ AAT	$24.8x10^6$	Yes	Porsuk	$286x10^6$	III	III	Few
GASKİ AAT	$73x10^6$	**Yes**	Saur creek	**?**	**?**	III	**??**
Tarsus Belediyesi AAT	$12x10^6$	**Yes**	Berdan	$2.8x10^9$	II	II	**Few**
Kayseri AAT	$33x10^6$	Yes	Karasu	$123x10^6$	IV	IV	**Few**

Wrap-up: Turkish Wastewater Statistics -1

Source: SIS & the MEDAWARE Project

- 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
- Around 1 billion m3 wastewater is being secondary (biologically) treated

Wrap-up: Turkish Wastewater Statistics -2

Source: SIS & the MEDAWARE Project

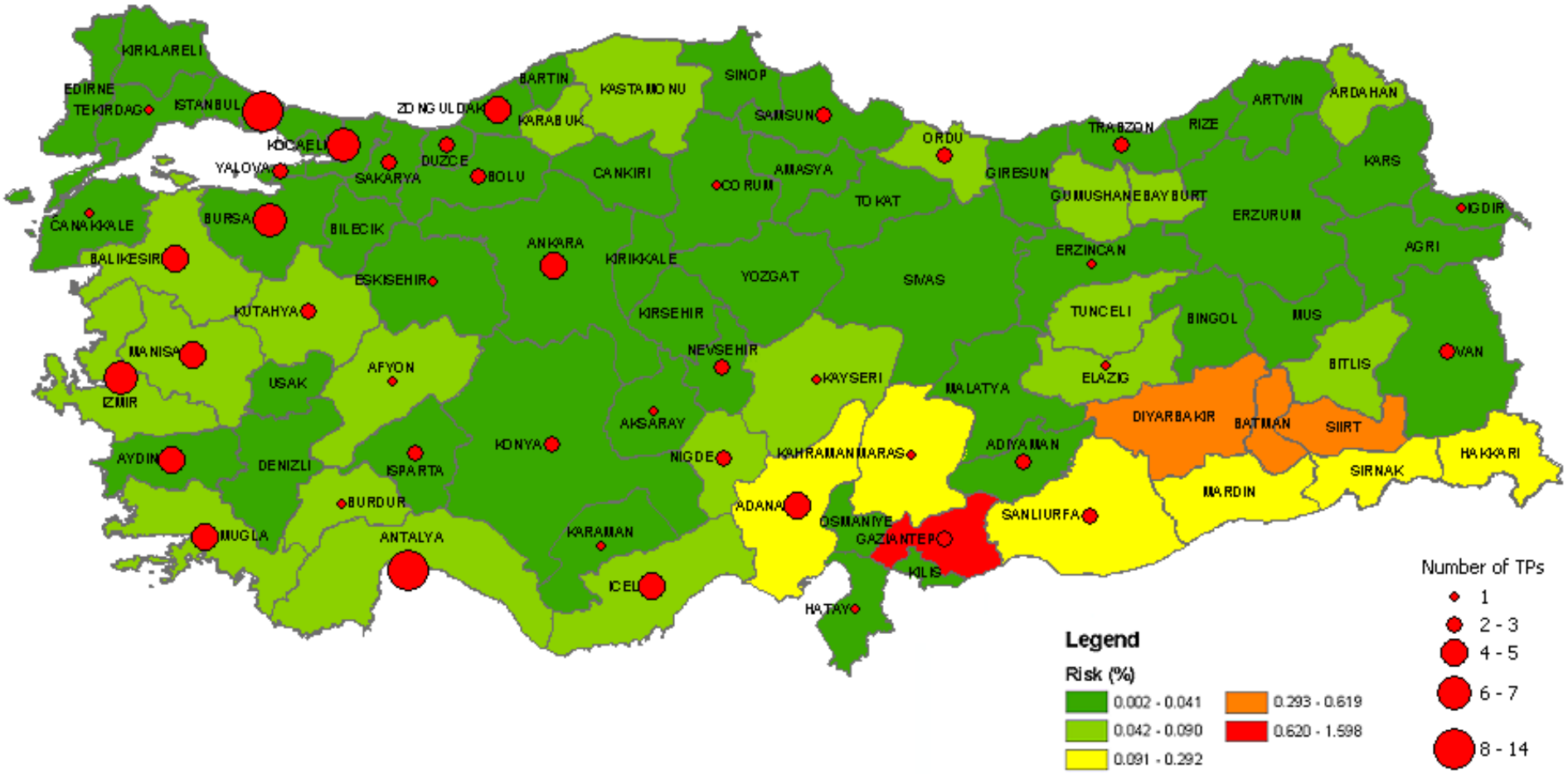
- 9 advanced-nutrient treating (BNR) plants in operation
- the BNR plants produce effluents compliant with the 91-EU Directive
- a total of 0.208 billion m3 wastewater is advanced treated per year
- 14 Plants are extended aeration plants; the *likelyhood of bacteria removals should be high in these*
- 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.

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

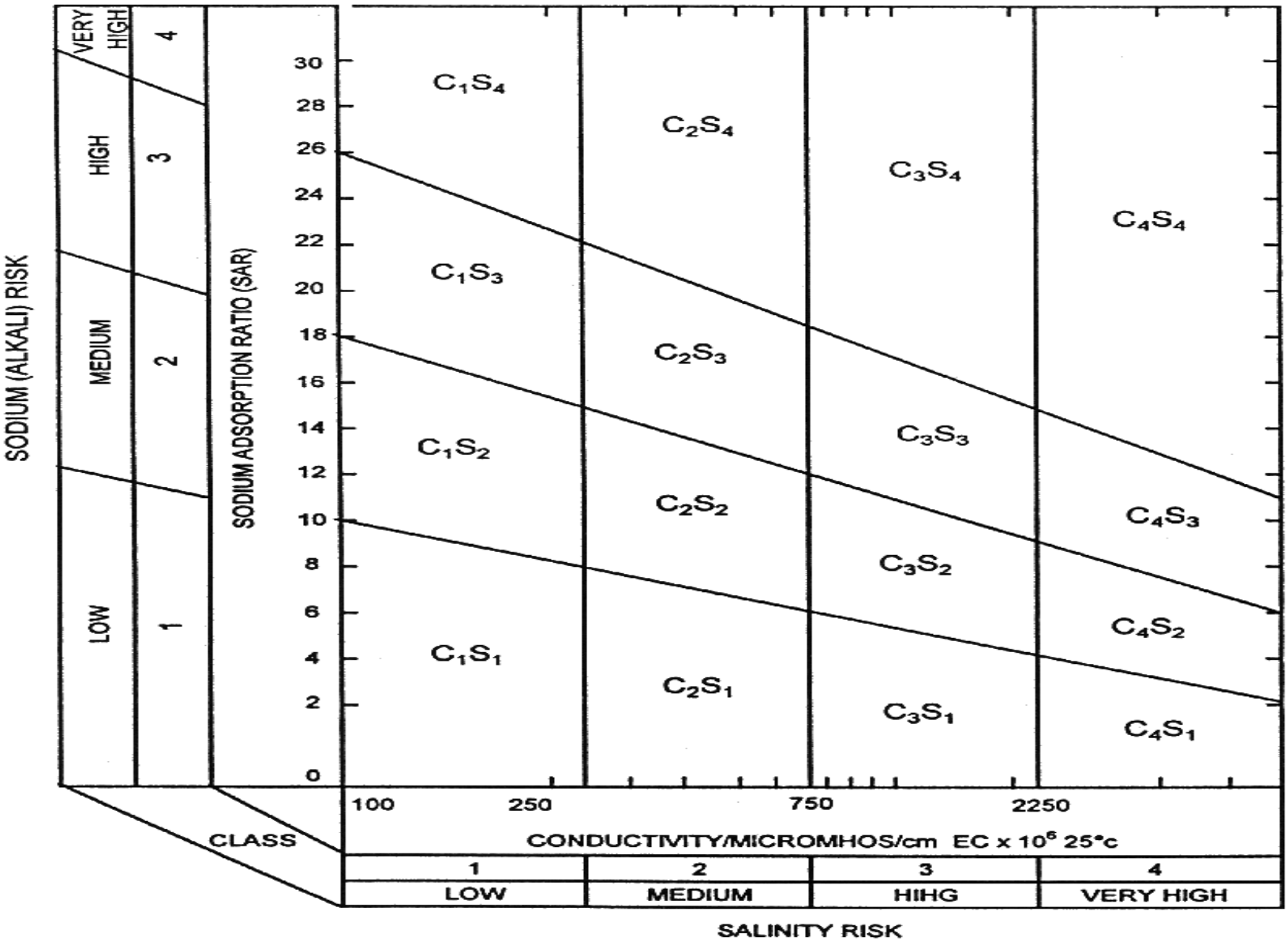
Province	Place	Name of plant	m3/a	Receiving environ.	Irrigation status
Aksaray (Primary t.)	Merkez	Aksaray Municipality WWTP	9 125 000	Karasu Stream	INDIRECT *
Ankara	-	ASKI, Ankara Municipal. WWTP	192 695 545	Ankara Creek	INDIRECT *
Eskisehir ** #	-	ESKI, Municipality WWTP	24 820 000	Porsuk River	INDIRECT *
Gaziantep ** #	-	GASKI , Municipality WWTP	73 000 000	S. Creek	DIRECT
Igdır (aer. Stabilization))	Merkez	Igdır Municipality WWTP	551 880	Aras River	DIRECT
Kayseri #	-	Kayseri Municipality WWTP	32 850 000	Karasu River	INDIRECT *
Adana	Kozan	Kozan Municipality WWTP	2 780 000	Kozan Creek	INDIRECT *
Adana	Yumurtalık	Yumurtalık Municipality WWTP	48 000	Ayas Creek	INDIRECT *
Konya	Ilgin	Ilgın Municipality WWTP	2 838 240	Bulasan River	INDIRECT *
Nevsehir	Urgup	Urgüp Municipality WWTP		Damsa Creek	INDIRECT *
İzmir #	Merkez	IZSU Municipality WWTP	182 500 000	Izmir Bay	DIRECT/Gediz Plane

WWTP: Wastewater Tr. Plant.; * INDIRECT: Treated wwtrs are given to a river, from where they 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 Polution Control Regulation, Technical Aspects Bulletin 1991) - 1



Turkish Water Reuse Standards in Crop Irrigation (Water Polution 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 Polution 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

Municipal Watewater Treatment Costs

Extended Aeration Plants:

Municipality	Investment (million €)	Investment (€/p.e)	electricity (kwh/month)	Running cost (€/year)	Unit rn. cost (€/m^3)
Akçakoca	1.16	29	83.700	215,000	0.126
İzmit	6.83	43.78	445.000	245,000	0.032
Ürgüp	-	-		-	-
Tarsus	15.6	49.85		-	-
Kemer *	2.92	80.00		590,000	0.1534
Kumkoy *	1.4	12.72	161,100	212,100	0.0528
Belek 1 *	1.67	23.85		270,000 – 450,000	0.0752
Belek 2 *	1.67	23.85		270,000 – 450,000	0.0747
Avsallar *	1.92	83.47		-	
Titreyengöl	1.55	28.18	96,913	176,400	0.0450

*** N- Removing plants**

Conventional Activated Sludge Plants - 1

Municipality	Investment (million €)	Investment (€/p.e)	electricity (kwh/month)	Running cost (€/year)	Unit running. cost (€/m^3)
Gaziantep	46.67	46.67			
Nizip	1.26	13.76	120,000	329,670	0.0903
Tuzla			1,000,000	2,500,000	0.0394
Karabuk	2.83		194,400		
Kutahya	5.00	22.00	280,000		
Marmaris			195,150	769,230	0.0468
Nigde			183,600		
Van			275,000		

Conventional Activated Sludge Plants - 2

Municipality	Investment (million €)	Investment (€/p.e)	electricity (kwh/month)	Running cost (€/year)	Unit running. cost (€/m^3)
Kozan			32,400		
Ankara *	142.66	36.58	2,394,634	3,391,923	0.0176
Nazilli	3.62	33.41	120,000	494,508	0.0753
Burhaniye			189,000		
Corum			226,000		
Elazig			224,000	277,777	0.0190
Eskisehir	7.23	24.10	387,116	363,474	0.0146

* Generating own electricity

Nutrient Removing BNR Plants

Municipality	Investment (million €)	Investment (€/p.e)	electricity (kwh/month)	Running cost (€/year)	Unit running. cost (€/m^3)
Iskenderun	14.15	32.3	370,195	535,000	0.0488
Kayseri	47.4	59.3	1,050,000	1,553,049	0.0473
Fethiye	8.12	266.2	277,421	488,606	0.0553

Comparison of Treatment Costs

Treatment Technology	Initial Cost (€/capita)	Unit Operational Cost (€/m^3)
Conventional activated sludge	13.76 – 46.67	0.0146 – 0.0903
Denitrifying activated sludge	32.30 – 266.2	0.0473 – 0.0553
Extended Aeration act. sludge	29.00 – 49.85	0.0320 – 0.1260
Denitrifying oxidation ditch	12.72 – 83.47	0.0528 – 0.1534
Vacuum membrane reactor MBR *	250 - 330	0.13 € electricity 0.45 € elctrcity + membrane cost

*** Based on Observations on 1500 p.e METU VRM plant**

Irrigation costs and Evaluation

Fundamental Calculations

Assumptions

- **Single crop of corn requires 500 mm water**
- **2.0 tons of corn may be produced per hectare**
- **Selling price of one ton corn is around 267 US$**
- **534 $ / 5 000 m3 = 0.107 $ revenue/m3**
- **= 10.7 cent/m3**

Costing

- **Extra cost of caogulation/ flocculation/ filtration over secondary treated w.water is around 5 US cents /m^3 (Israeli data) to produce 0 coliform/100 (according to the current Turkish and US etc. Standards) water.**
- **This is around 15 cents/m^3 with Membrane filtration (Israil)**
- **In VRM MBRs this is 13 cents/m3 energy cost; 40-45 cents /m3 total treatment cost, inclusive of membrane cost (METU VRM)**

Costing - Conclusion

- **Currently, according to legislations secondary treatment is paid by the community & tertiary treatment by the farmer.**
- **Considering the cost of fertilizers, diesel fuel, land, living expenses etc. 5 cents/m3 is not acceptable by the farmers.**
- **Lagooning and trickling filters may paroduce effluents virtually at no cost.**
- **Lagoons produce near zero coliforms but extremely turbid effluents. This is still not acceptable.**
- **Unless treated waters are crystal clear, they can not be disinfected by UV.**
- **UV Disinfection costs have become comparable to chlorination costs. Latter produces cancerous products.**

Reuse Standards and their Implications

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 areas with no access to the public.	≤ 1	None required	≤ 35 ≤ 150[f]	Secondary treatment or equivalent[g] + a few days storage or Oxidation pond systems

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

Category IV				
a) Irrigation of vegetables guaranteeing absence of contact between reclaimed water and edible part of vegetables. b) Irrigation of crops in category III with drip irrigation (such as drip, bubbler, micro-sprinkler and subsurface). c) Irrigation with surface with drip irrigation of greenbelts and green areas with no access to the public. d) Irrigation of parks, golf courses, sport fields with sub-surface irrigation systems.	**None required**	**None required**		**Pretreatment as required by the irrigation technology, but not less than primary sedimentation**
Category V				
Groundwater recharge: a) Surface spreading into non-potable aquifers	-	**None required**	**≤ 35**	**Secondary treatment or equivalent (g)**
b) Surface spreading into potable aquifers	-	**≤ 1000(d)**	**≤ 20**	**Secondary treatment or equivalent (g) + filtration + disinfection Advanced**

Source: Blumenthal, U. J., Mara, D. D., Peasey, A., Ruiz-Palacios, G. and Scott, R., 2000. Guidelines for the microbiological quality of treated wastewater used in agriculture: recommendations for revising WHO guidelines. *Bulletin of the WHO* Vol.**78** (

Israeli Irrigation Water Quality Standards for Wastewater Reuse

Parameters	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 vegetables eaten uncooked (raw), parks and lawns
Effluent quality				
BOD_5 total (mg/l)	60[a]	45[a]	35	15
BOD_5 dissolved (mg/l)	–	–	20	10
Suspended solids (mg/l)	50[a]	40[a]	30	15
Dissolved oxygen (mg/l)	0.5	0.5	0.5	0.5
Coliforms counts (/100 ml)	–	–	250	12 (80%) 2.2 (50%)
Resid. avail. chlorine (mg/l)	–		0.15	0.5
Mandatory treatment				
Sand filtration or equivalent	–		–	required
Chlorination (minimum contact time, min)	–		60	120
Distances				
From residential areas (m)	300	250	–	–
From paved road (m)	30	25	–	–

[a]Different standards will be set for stabilization ponds with retention time of at least 15 days.[b]Irrigation must stop 2 weeks before fruit picking; 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****
ASKI, Ankara Central WWTP	1+2+4+5+7+8	15	2	A, B	I-III(N)
Alanya Central WWTP	1+2+4+7+8+11+12**	8	1	A, B	I
Antalya Hurma WWTP	1+2+4+7+8+9+11+12**	10	1	A, B	I-II(N)
Elazig Municipality WWTP	1+2+4+5+7+8+12	16	2	A, B	I-II(BOD_5)
Erzincan Municipality WWTP	2+4+7+8	15	2	A	I-III (BOD_5)

Conformity of the selected plants to Turkish and Israeli standards and to Mediterranean 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

CONCLUSIONS - 1

- A large fraction of the population is connected to treatment plants (35 %) 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 treatment facilities.
- The microbiological standards stipulated by the 'Technical Aspects Bulletin' for wastewater reuse in Turkey, and those in US-Title 22 are unrealistically stringent for Turkey, and ought to be updated in the light of the current scientific evidence.

Conclusions - 2

The cost of extra treatment exceeds, or approach to, the selling price of crops.

- **For example *Blumenthal et al.* (*2000)* proposes a trade off between cost of treatment and level of treatment and the health impact. Accordingly, secondary treated effluents may safely be used in restricted irrigation following a mild and low-cost treatment, such as lagooning, disinfection or both.**

CONCLUSIONS-3

- In case of reuse for domestic purposes, adoption of Title 22 or equivalent are inevitable.
- This can be financed by appropriate water tariffs.

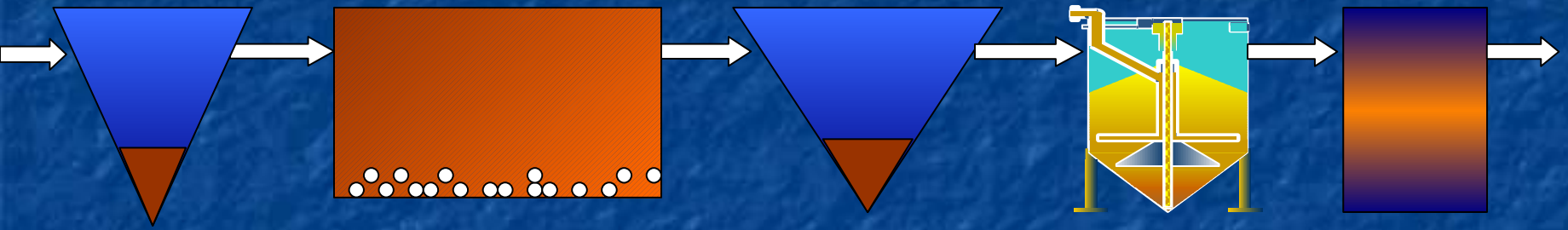
CONCLUSIONS - 4

- 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

Research being carried out towords the goals of MEDAWARE Project in METUI

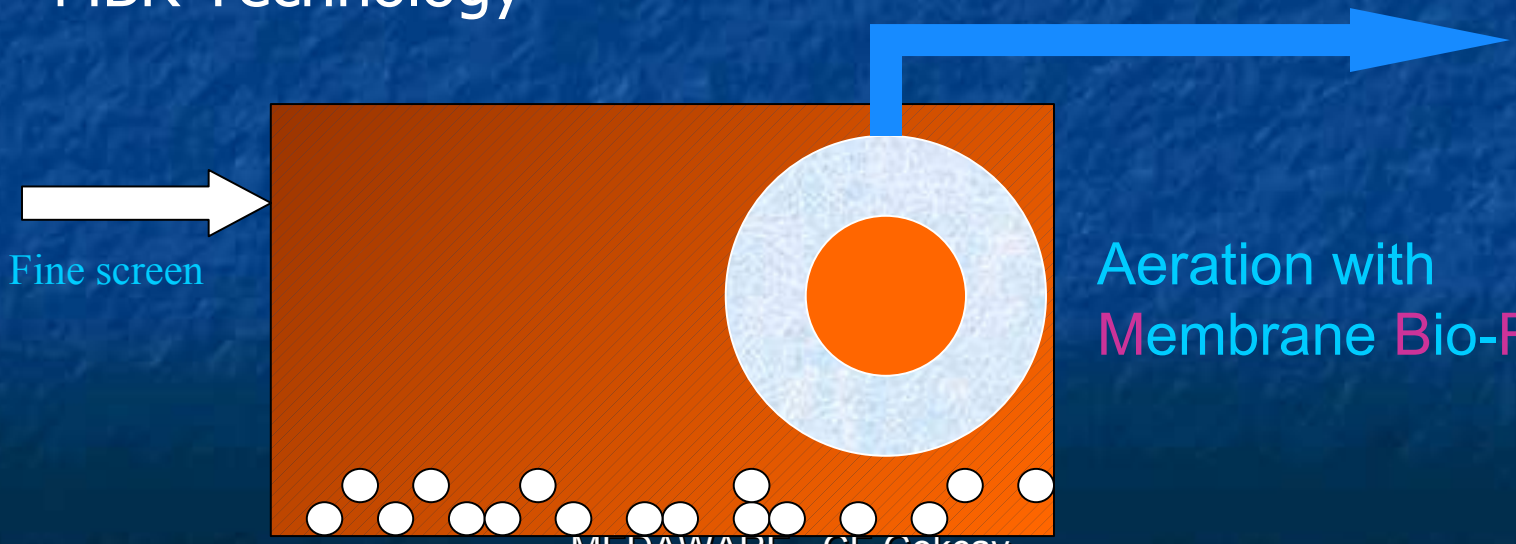
METU-VRM Project

Conventional Treatment and Re-use



primary clarification aeration final clarification sand filter UV treatment

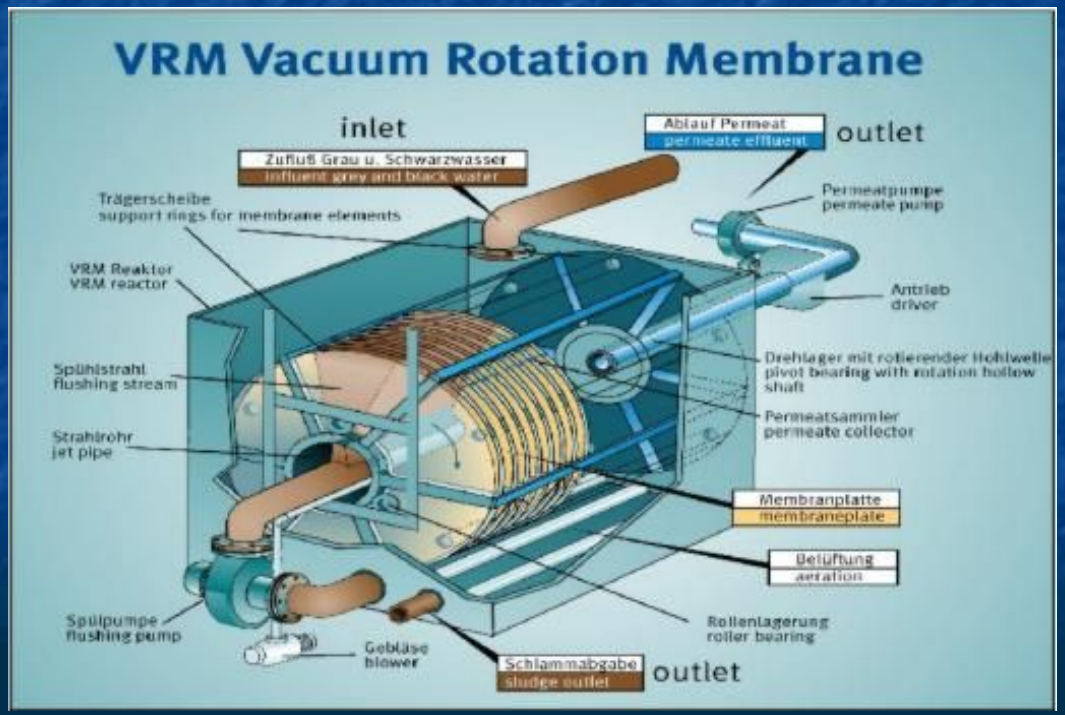
MBR Technology



Aeration with
Membrane Bio-Reactor

Vacuum MBR - VRM

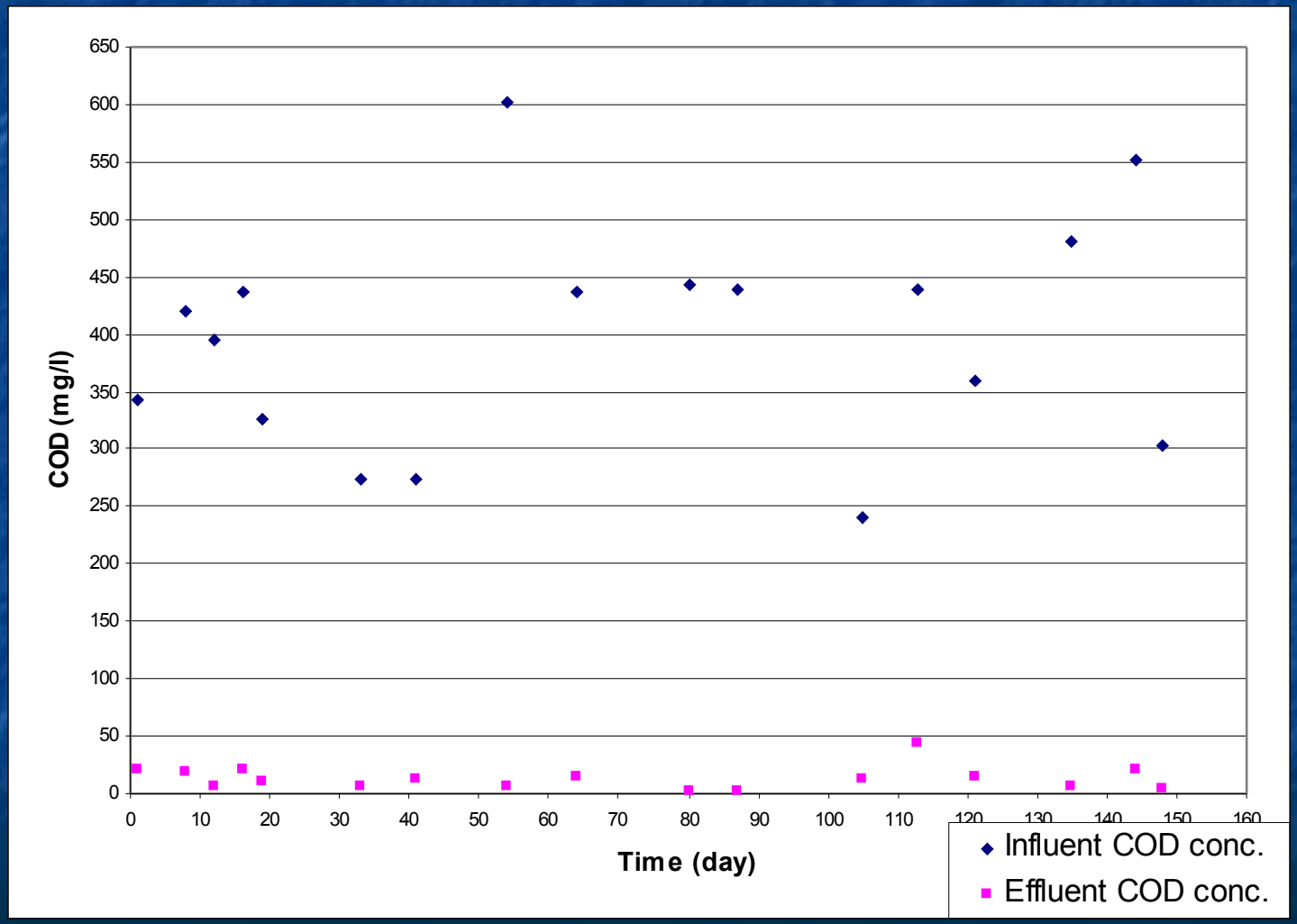
VRM and Membrane Plates



METU VRM Plant

METU VRM Plant

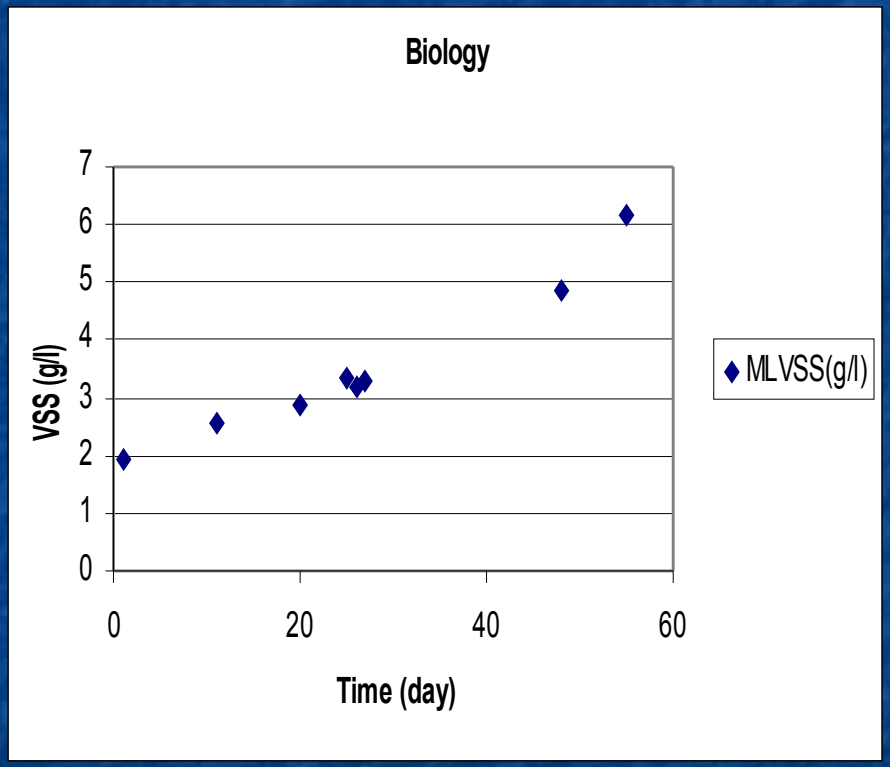
COD Removals in VRM

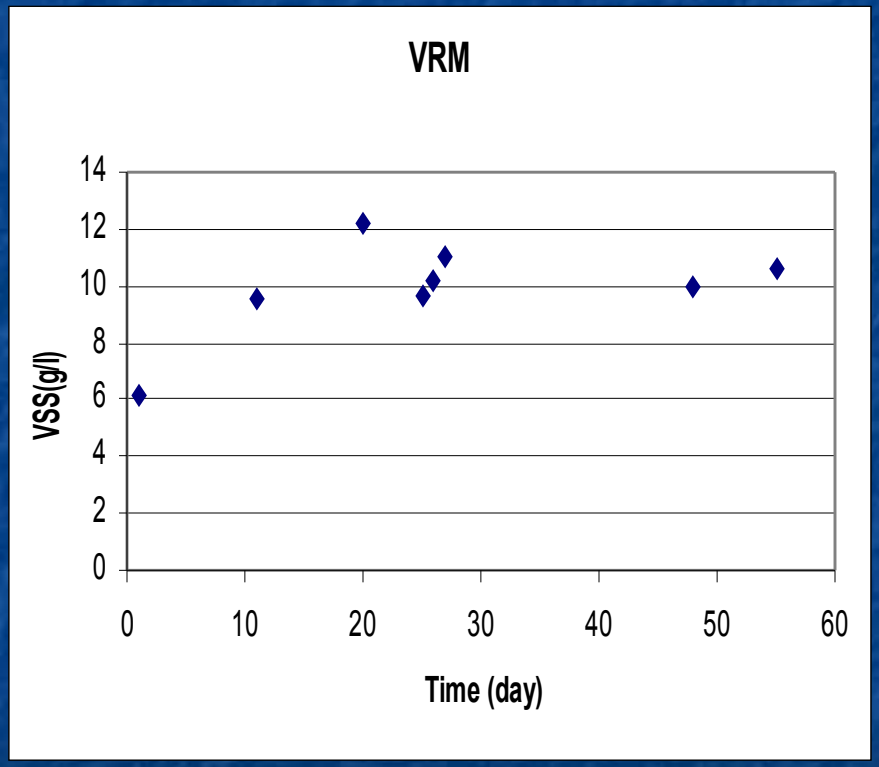


Coliform Removals in VRM

Date	Effluent F.C.(adet/100ml)	Effluent T.C.(adet/100ml)
05.04.2005	3	212
14.04.2005	0	220
15.04.2005	4	21
28.04.2005*	0	162
06.05.2005	1	159
17.05.2005	1	218
27.05.2005	3	210
30.05.05*	0	142
14.06.2005	2	242
25.06.2005**	0	142
06.06.2005	4	330
22.06.2005	2	218
17.07.2005**	0	350
25.07.2005**	210	>1000
27.07.2005**	18	
28.07.2005**	13	
02.08.2005**	2	
16.08.2005**	0	
25.08.2005**	2	

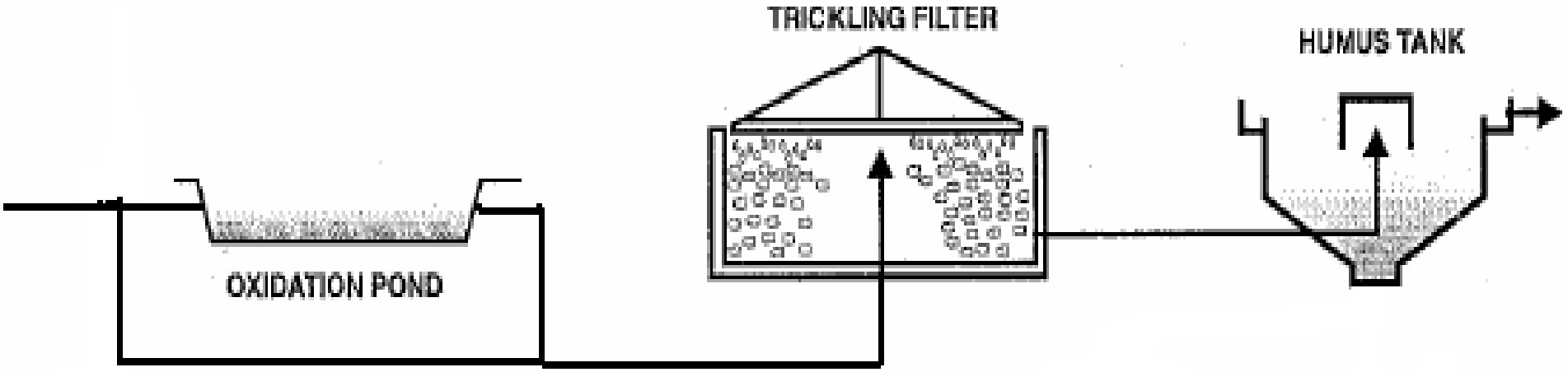
Dry Solids Content in Chambers





REMOVAL of ALGAE Using TRICKLING FILTERS for Lagoon Up-grade

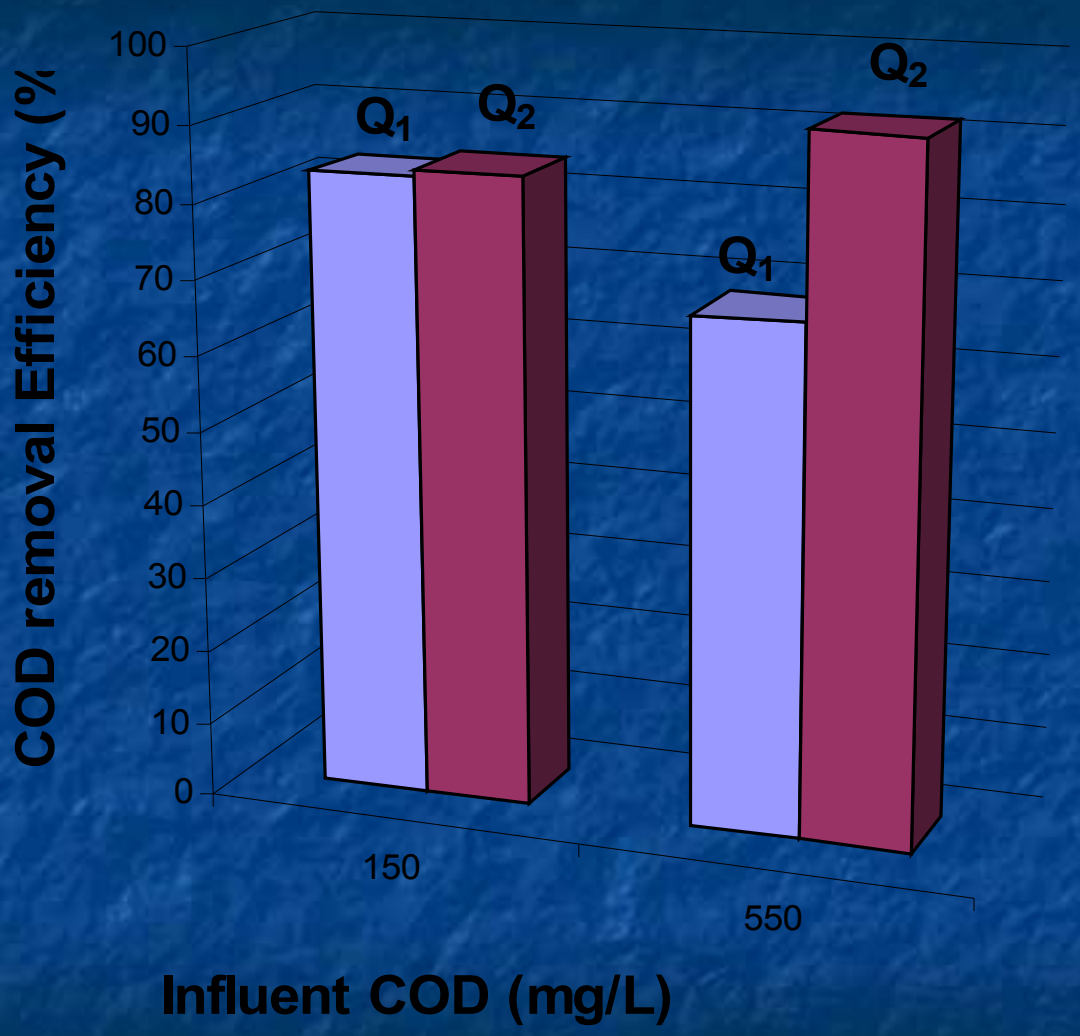
Step Feed Dual Treatment (SFDT)



Represantation of Step Feed Dual Treatment (SFDT)


ATTIRE
CONDUCT
PROPER HANDLING

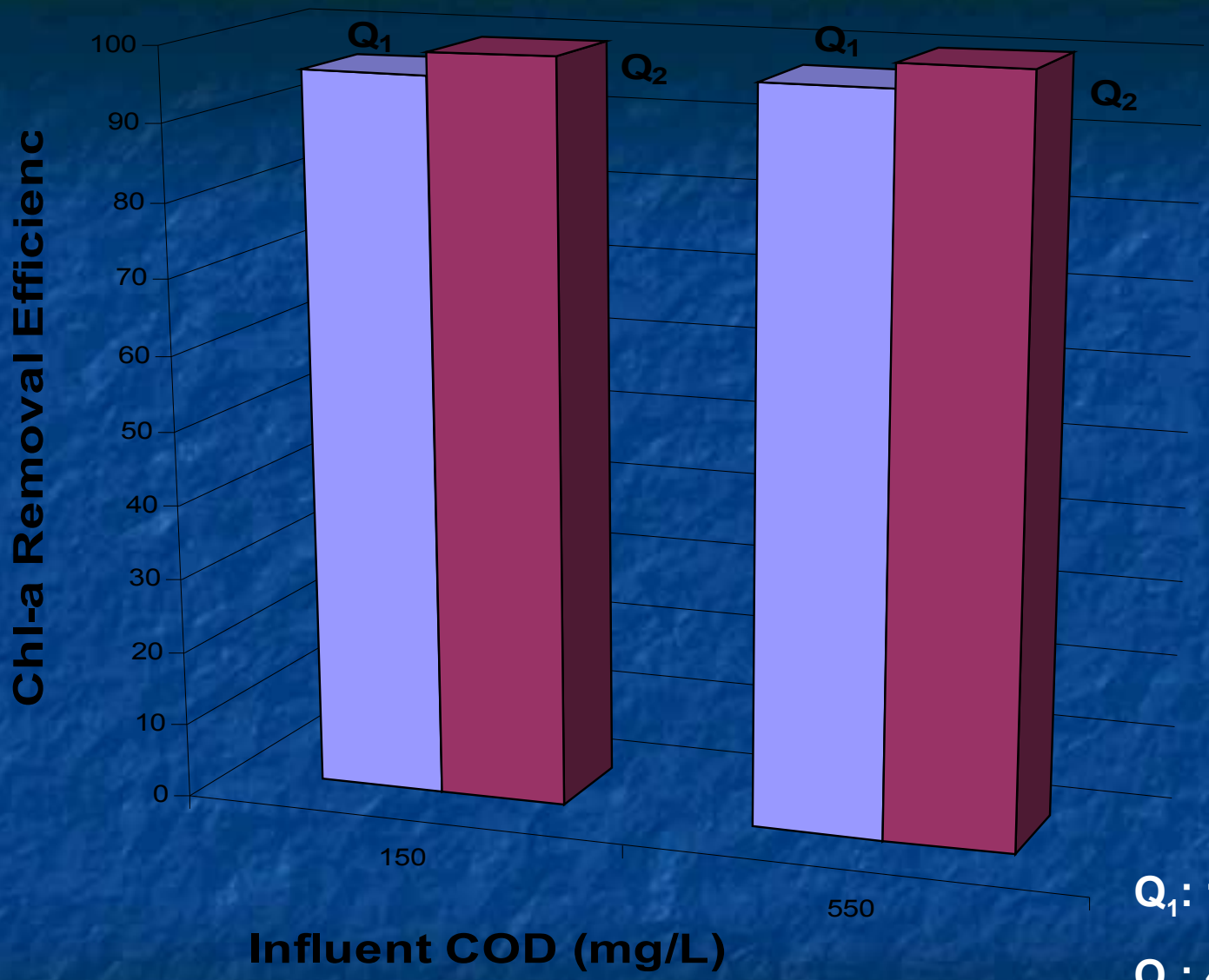
Top sight of the filter column



Q_1: 16 L/day

Q_2: 4 L/day

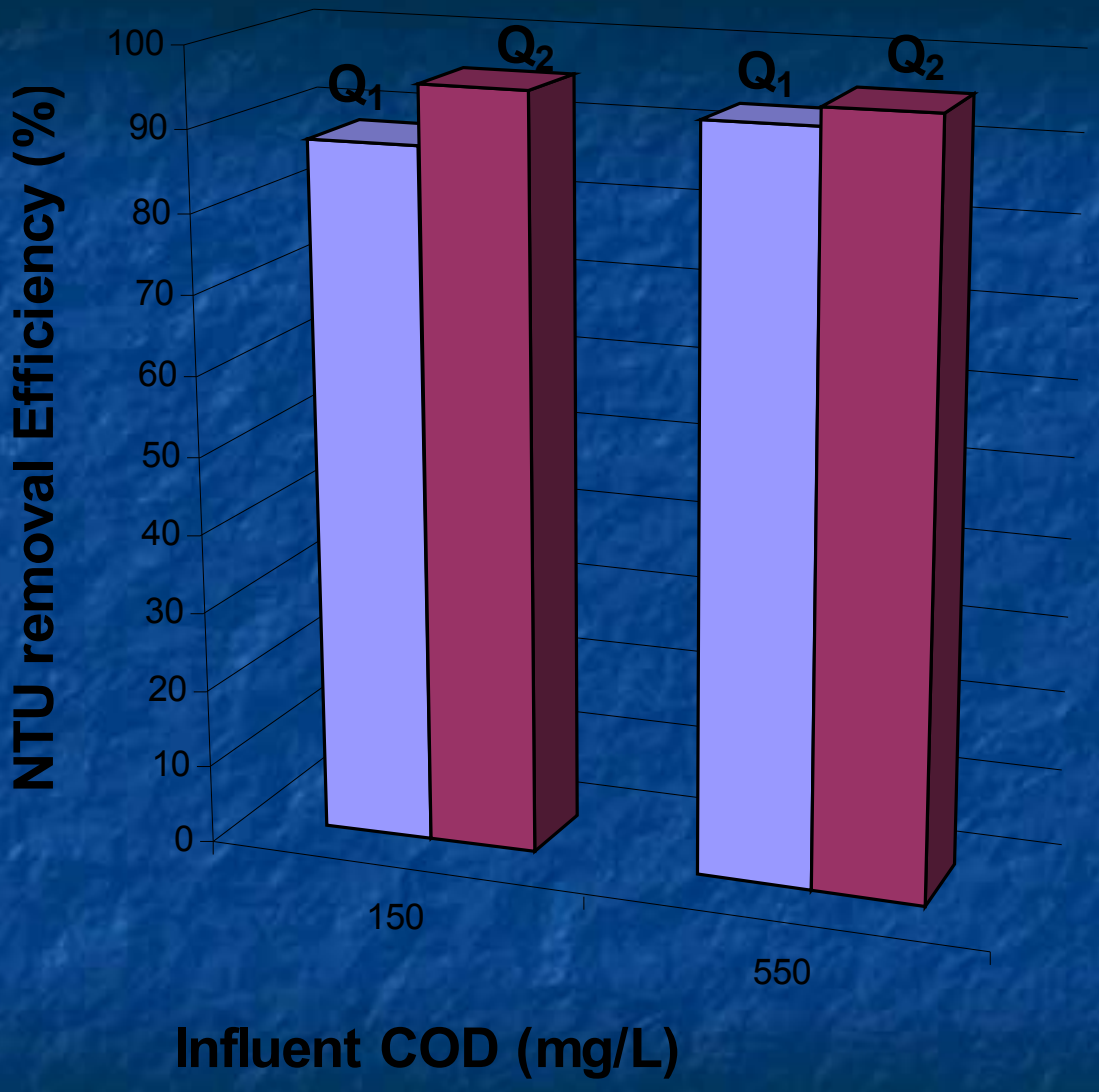
COD Removal Efficieny



Q_1: 16 L/day

Q_2: 4 L/day

Chl-a Removal Efficieny



Q_1: 16 L/day

Q_2: 4 L/day

NTU Removal Efficieny

Oxidation Pond Outlet

Trickling Filter Outlet

- SFDT process consistently produced clear effluents with < 2 NTU up to 2 HLR (m^3/m^2.day) , thereby meeting the WHO guidelines for unrestricted irrigation.
- Effluents were clear enough for subsequent UV treatment.
- Cost of treatment was near Zero if no pumping is necessary
- Around ¼ wastewater will be channeled to the Trickling filter and rest to the lagoon(s)

THANK YOU FOR YOUR INTEREST

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More Information on MEDAWARE Peoject:

http://www.emwis.org/MEDA/medaware.htm