Agricultural Reuse of Treated W/W Effluent: The experience of the Thessaloniki Wastewater Treatment Plant (2007-2012)

Thessaloniki Water Supply & Sewerage Company (EYATH SA)

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Thessaloniki area, 1M inhabitants

EYATH's premises A.E Egnatia str.

Cleaning of Thermaic Gulf

Watergate at Aliakmon river

Thessaloniki's wastewater treatment plant.

Effluent reuse from ThWWTP

- **Triggers :**

1) Various requests to employ the reuse of treated wastewater from various parties
2) Prolonged hot summers or periods of drought
3) Higher demand for agricultural irrigation supply

- **First steps:**

1) Participation in existing research programs of NAGREF with disposal of treated ThWWTP effluent.
2) Communication attempts with local authorities and the Farmers Union

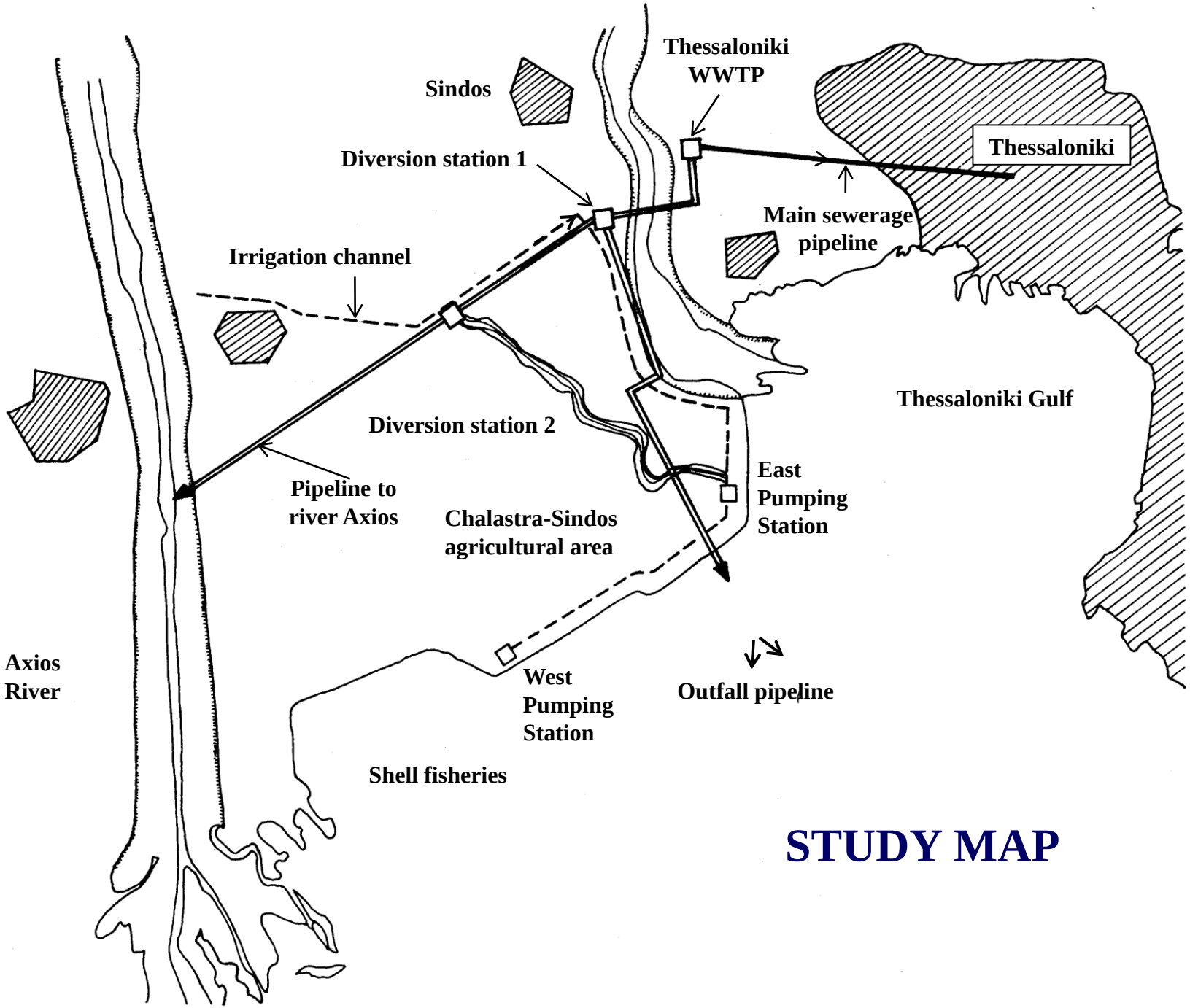
Project's Targets & Objectives

- EYATH's main objective has been to provide a cost-effective, sustainable water resource in a tight footprint while reducing discharges to the aquatic environment. Furthermore:
- To cope with water shortage as a Climate Change (C.C) consequence that requires alternative water resources availability.
- To contribute to the reuse of nutrients in the environment.
- To act proactively having a positive impact on environmental and societal local needs.
- To use reclaim processes in all EYATH's wastewater treatment plants, if possible.
- To move towards implementation of the requirements of the River Basin Management Plan (RBMP) for the area

Context of the project

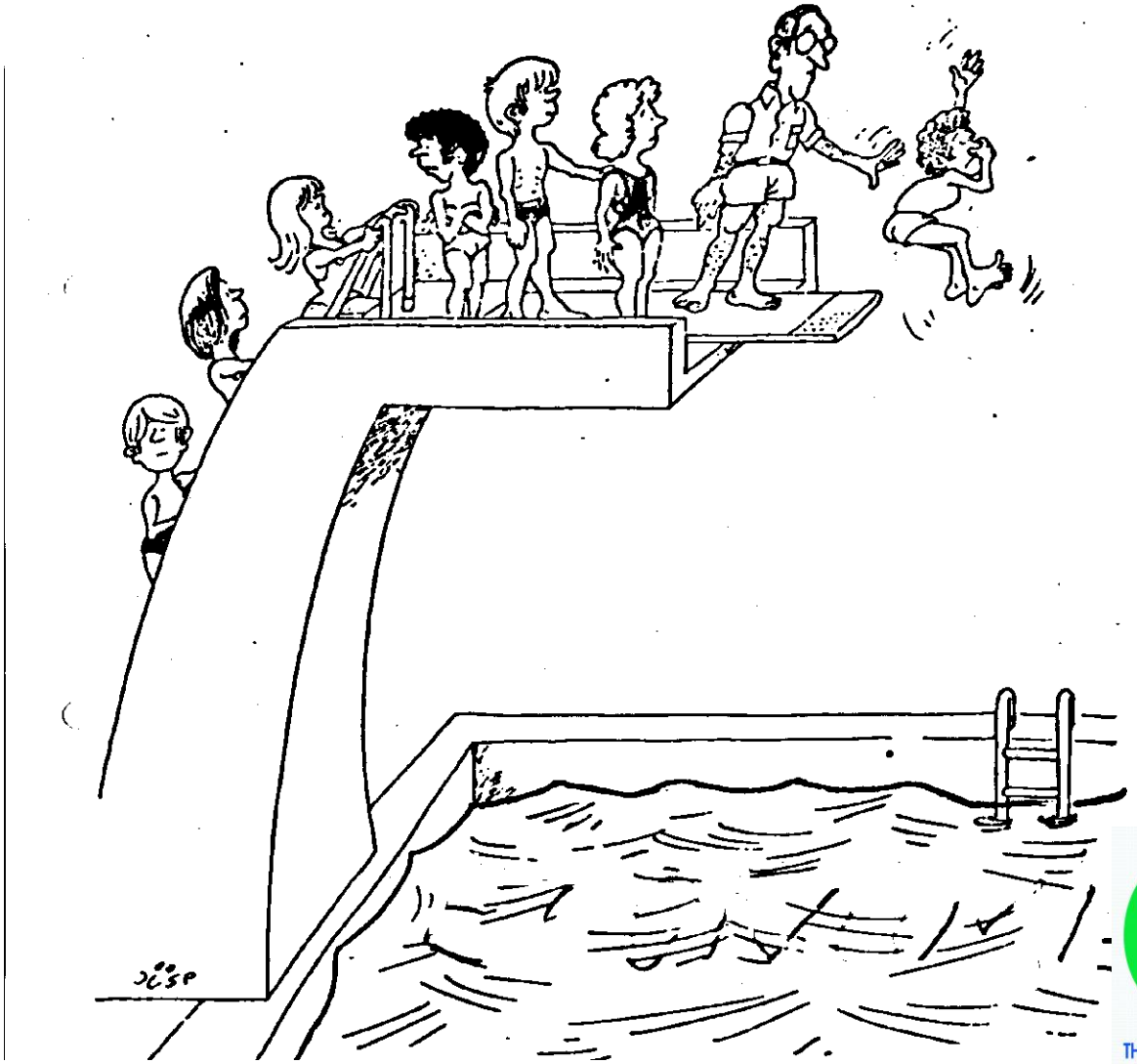
- The northwest area of the city is surrounded by cultivated fields and is close to the ThWWTP
- Reclamation of treated wastewater effluent for restricted irrigation in agriculture fields, during the summer periods of the years 2007 to 2012
- 180.000m3 of treated effluent were reclaimed for irrigation on a daily basis, during periods and with no cost for the end-users specific short
- Rice, corn, and cotton were the main crops of the area

Thessaloniki’s wastewater treatment plant


Thessaloniki
WWTP
Sindos
Diversion station 1
Thessaloniki
Main sewerage
pipeline
Irrigation channel
Thessaloniki Gulf
Diversion station 2
East
Pumping
Station
Pipeline to
river Axios
Chalastra-Sindos
agricultural area
Axios
River
West
Pumping
Station
Outfall pipeline
Shell fisheries

STUDY MAP

Reuse of WWTP effluent for irrigation
Jumping at a deep end!



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EYATH's WATER REUSE PROJECT

Environmental Factors

Technical Factors

Economic Factors

Social Factors

Environmental Factors

- **No regulative Framework existed**

- **Monitoring and Analytical work for feasibility study:** monitoring analyses were made and analytical data (also from previous research work) concerning the quality of the ThWWTP effluents and irrigation water was collected

- **Studies and permits (EIA)**

LEGISLATION IN GENERAL FOR RE-USE CONDITIONS (CRITERIA & LIMITS)

- WHO (2006) , State of California(2000), US EPA (1992)
- Several countries (Spain, Israel, Cyprus, Australia ..)

- Comparison of treated effluent parameters with the existing irrigation water of river Axios
- and proposal of a monitoring scheme.

Physicochemical analysis

PARAMETERS	UNITS	ThWWTP EFFLUENT	IRRIGATION WATER
PH		7.4-7.8	7.8-8.2
Conductivity	ms/cm	3.5-5.5	0.5-1.0
SS	mg/l	15-25	10-18
BOD5	mg/l	10-23	2-4
COD	mg/l	60-80	13-22
Cl	mg/l	800-1200	50-100
NH4-N	mg/l	1.5-6.0	0.2-0.4
NO2-N	mg/l	0.2-0.4	0.01
NO3-N	mg/l	1.0-1.3	0.6-2.0
TKN	mg/l	6.0-8.5	1.2-2.8
Total N	mg/l	10-17	1.5-4.5
P-PO4 orth0	mg/l	17-25	0.4-0.8
P-PO4 total	mg/l	3.0-6.5	0.4-1.0
B	mg/l	0.8-1.2	0.5-1.4

Heavy metals analysis

METAL (mg/l)	ThWWTP effluents	IRRIGATION WATER	INDUSTRIAL W/W effluents
Cu	0.01-0.05	0.01	0.04-0,07
Zn	0.03-0.06	0.2-0.3	0,02
Pb	< 0.1	<0.1	<0.1
Cd	0.005-0.01	<0.001	<0.01
Fe	0.2-0.6	0,8-1.5	0.6-1.5
Ni	0.05-0.07	<0.1	<0.1
Mn	0.04-0.05	0.1-0.2	
Cr	0.01-0.02	<0,01	0,015

Microbiological analysis

Microbiological Parameters	ThWWTP Prior to disinfection	ThWWTP effluent after disinfection	IRRIGATION WATER
Total Coliforms /100ml	*$2.4\text{-}4.6\times10^4$*	*1000 - 80*	*100 -2400*
E.Coli /100ml	$2.4\text{-}4.6\times10^4$	<3 - 200	150 - 930
Parasites (helminths)	----	Absence	Absence

Comparison of treated effluent parameters with the irrigation water of river Axios:

- **All the physicochemical parameters, apart from chloride ions and conductivity ensure a safe reuse of the effluent for agricultural purposes.**
- **No difference in quality between the effluent of ThWWTP after disinfection and the irrigation water concerning the microbiological results**
- **In addition, no parasitic elements of protozoan or metazoan parasites were found after parasitological examinations**

Pilot Project: Comparison of fertilized plot of rice field against effluent reuse without fertilization

Trials	Yield Kg/1000 m^2	Plant Height (cm)	Weight of 1000 grains (gr)	Total yield of milled grain (%)	Yield of whole grains (%)
Effluents from ThWWTP without fertilization	863	86.5	27.6	71.5	60,5
Effluents from ThWWTP with surface fertilization (3.75 -0-0)	826	86.8	27.8	71.3	60,3
Irrigation water Complete fertilization (15 (10+5) -5-0)	846	87.0	27.8	71.3	61.0

Comparison of fertilized plot of rice field with effluent reuse without fertilization

- ☑ Soil analysis, microbiological analysis of plant tissue and outflows and agronomic rice traits were measured.

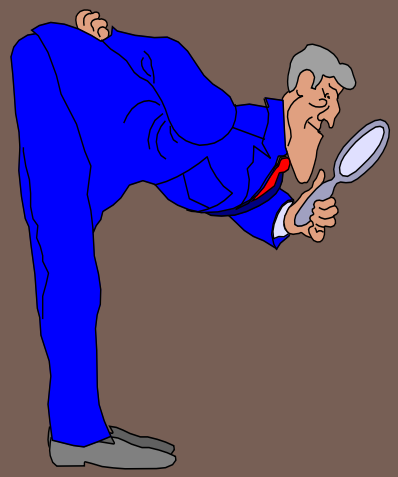
- ☑ No significant differences either in the soil or in the rice traits between the plot which was fertilized and watered in the normal fashion and used as a check and the other two plots

- ➢ **ADVANTAGE:** No fertilizer was needed as recycling of the nutrients (N,P) in the treated effluent seemed efficient

Technical Factors

- **Sewerage network: Saline Water intrusion.**
  The problem of increased conductivity was faced by dilution in river irrigation channel and online monitoring
- **Feasibility Study**
- **Efficiency of the Wastewater Treatment Plant:**
  Secondary treatment with Chlorine disinfection
- **Construction Works :Minor engineering works were need as the diverting channel already existed**
- **Co-operation with relevant institutions**

Economic Factors



- € Low cost budget and the low personnel needs
- € The financial expenses were basically for covering the monitoring analysis needed
- € Self-financed by the company's research funds
- € No cost for End Users (and less fertilizers use)
- € Possible monetary and no monetary gains by a Future Reuse Strategy

Social Factors

- Health and Safety Issues are of higher Importance
- Informing the media and the public
- Public acceptance & involvement
- Informing the users (farmers)
- Informing EYATH's personnel involved in the project
- Informing the decision makers (elected officers, regulators)

Which sectors of society usually oppose to the reuse of wastewater in agriculture?

- Farmers
- Consumer groups
- Food producers & retailers
- Environmental Groups - NGOS
- Academics
- Central Government
- Local Government
- Permit Granting Authorities

The main obstacle has been the absence of an existing regulatory framework as an authorization tool for the verification and the reinforcement of the project towards precarious and reluctant stakeholders

Key players

- Highly motivated personnel of the EYATHs Research and Development Department
- Collaboration with well educated personnel of local environmental auditing authorities
- Institutional researchers already experienced in Water Reuse pilot projects (funded by EU research programs)

The Results

Corn irrigation at Sindos area

Mixture of treated effluents plus river water that go for irrigation

Legislation-Permits

- The project was licenced by the Water Directorate of Central Makedonia and was approved by the local Farmers Union.
- A National Legislative Framework on Water Reuse was established in 2011: Very strict and prohibitive for further action (2013)

Lessons Learned

- Water Reuse for agricultural purposes can **foster existing water resources capacity** to cater for other urban water needs, **facing CC challenges**. This can result in **saving costs**. It can also contribute to the recycling of nutrients on land.
- Special care to ensure that the reuse programs are well managed, with the utmost attention being paid to **protecting public health**.
- **End users' perception was of key importance in the acceptance of the project.** The **credibility and motivation** of the personnel involved, along with **informational and educational programs** for the public and the farmers were essential for the success of the project.
- Moreover, **co-operation with agricultural groups** have to be established and the feed- back of their views has to be taken into account.

Lessons Learned

- The need of **new technologies** and infrastructure to better monitor saline water intrusion at the network of EYATH is crucial.
- At present, we need to adapt the application of this project to the new terms & limits set by the recently established Greek Legislation framework on reuse and reclamation of water.
- **SO Larger Scale Investments are Needed**
- **BUT ALSO Legislation criteria have to be realistic**

Conclusions

New "sustainable" water resources management strategies=>legislative amendments

- **Only then technologies of sustainable water reuse can be viable**
- **The need for a common European Guidance on water reuse is essential**

BUT: Taking into account the intense water demands of Southern countries facing CC challenges

Thank you for your attention!

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