Best Practice Examples for Reuse of Wastewaters in Agricultural Irrigation in the World

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Why reuse wastewater in agricultural irrigation?

Only 1% of the total amount of water available on earth is freshwater. Currently, we are allocating a significant portion of the freshwater resources for agricultural irrigation. With the use of reclaimed wastewater for agricultural irrigation

- **Freshwater resources can be reserved for domestic and other uses,**
- **Chemical fertilizer usage can be minimized since nutrients required for plant growth can be supplied with the reclaimed wastewater**
- **Discharge of reclaimed wastewater to water bodies can be prevented**

Although wastewater reuse applications have initially tailored for activities such as small scale irrigation of gardens, toilet flushing, etc., current applications are trending for large scale agricultural irrigation. Today, many countries are allocating resources to improve wastewater reuse studies and applications, and establishing guidelines for that purpose.

Scope of this study

The aim of this study is to investigate various applications of wastewater reuse in agricultural irrigation in developed and developing countries. In selecting these cases, special attention has been given to suitability to the Mediterrannean Countries. Cases examined were from Australia, Cyprus, France, Israel, Jordan, Spain, Tunusia, Turkey, and USA. Facilities operated in these countries are examined based on several parameters such as the volume of wastewater processed, area of land irrigated, treatment technologies utilized, crops irrigated, etc.

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Gaziantep Wastewater Treatment Plant, Turkey

Wastewater origin: Domestic wastewater of Metropolitan Gaziantep
Volume: 73 Mm^3/yr
Treatment before reuse: secondary treatment (detention facilities for irrigation and water quality enhancement is under construcrion)
Reclaimed water quality:
FC: not reported
BOD : <25 mg/L
TSS: < 35 mg/L
NH_3: 17 mg/L
NO_2: 2.5 mg/L
NO_3: 5.5 mg/L
Irrigated products: edible and other crops
Total area irrigated: 8.000 ha

Dan Region, Israel

Wastewater origin: Wastewater of Greater Tel Aviv Metropolitan Region ***Volume:*** 120 Mm^3/yr
Treatment before reuse: Tertiary treatment followed by soil aquifer treatment and storage
Reclaimed water quality:
FC: 0/100 mL
BOD : < 0.5 mg/L
TSS: 1 mg/L
NH_4: 0.02 mg/L
NO_2: 1.17 mg/L
NO_3: 0.28 mg/L
TP: 0.05 mg/L
Irrigated products: (unrestricted irrigation) cotton, cereals, sunflower, fruits, vegetables, etc.
Total area irrigated: 16.000 ha

Kishon Scheme, Israel

Wastewater origin: Domestic wastewater of Greater Haifa
Volume: 35 Mm^3/yr
Treatment before reuse: secondary treatment followed by storage in seasonal reservoirs
Reclaimed water quality:
FC: 1/100 mL (at end user,higher at reservoir inlet)
BOD : 8.2 mg/L
TSS: 20.7 mg/L
NH_3: 15.2 mg/L
NO_2: 7.1 mg/L
NO_3: 14.7 mg/L
Irrigated products: (restricted irrigation) cotton, sillage, and other non-edible crops

Tallahassee, Florida, USA

Wastewater origin: Domestic wastewater Volume: 33 Mm^3/yr
Treatment before reuse: secondary treatment
Reclaimed water quality:
FC: 200/100 mL
BOD : 20 mg/L
TSS: 20 mg/L
Irrigated products: restricted irrigation (corn, soybeans, coastal bermuda grass and rye, hay irrigation)
Total area irrigated: 700 ha

Al Samra, Jordan

Wastewater origin: Domestic wastewater
Volume: 55 Mm^3/yr
Treatment before reuse: Series of anaerobic and facultative ponds
Reclaimed water quality:
FC: >1000/100 mL
BOD : 12 mg/L
TSS: 150 mg/L
Irrigated products: restricted irrigation (olive trees, forest area, fodder crops, etc.)
Total area irrigated: 500 ha

Almeria, Spain

Wastewater origin: Municipal wastewater
Volume: 12 Mm^3/yr
Treatment before reuse: activated sludge, high speed filtration, ozonation
Reclaimed water quality:
TC: 100/100 mL
BOD : 35 mg/L
TSS: < 30 mg/L
Helmith eggs: 0
Irrigated products: vegetables and fruits (tomatoes, citrus, etc.)
Total area irrigated: 3000 ha

La Soukra Irrigation Area, Tunisia

Wastewater origin: Effluent from La Cherguia treatment plant
Volume: 22 Mm^3/yr
Treatment before reuse: secondary treatment (activated sludge)
Reclaimed water quality:
FC: 10^4/100 mL
BOD : 35 mg/L
TSS: 43 mg/L
TN: 42 mg/L
TP: 4 mg/L
Irrigated products: restricted irrigation (citrus trees, forage)
Total area irrigated: 600 ha

Virginia Pipeline Project, Adelaide, Australia

Wastewater origin: Treated wastewater from Bolivar wastewater treatment plant
Volume: 30 Mm^3/yr
Treatment before reuse: Primary sedimentation, trickling filters, stabilization lagoons, dissolved air floatation and filtration (An experimental aquifer storage and reservoir system is in operation as well).
Reclaimed water quality:
FC : 38/100 ml
TSS : 11 mg/l
Irrigated products: vegetables
Total area irrigated: 20,000 ha

Picton Wastewater Treatment Plant, Australia

Wastewater origin: Domestic wastewater from three towns
Volume: 0.44 Mm^3/yr
Treatment before reuse: tertiary treatment (intermittently decanting aeration lagoons, equalisation basin, anthracite filtration and UV disinfection, storage)
Reclaimed water quality:
BOD : 10 mg/L
TSS: 15 mg/L
TN: 0.37 mg/L
TP: 0.015
Irrigated products: lucerne, ryegrass, clover pastures
Total area irrigated: 90 ha

Outcomes

Within the considered cases, applications in Israel are the most notable ones in terms of capacity, effluent quality, application diversity, and suitability to the Mediterrannean region. Applications in United States of America and Australia are almost ultimate with respect to the technologies employed and the quality of the reclaimed wastewater. However, although noteworthy, these applications may not be suitable for the Mediterranean countries due to the economics of scale.

The safe use of reclaimed wastewater for irrigation can be achieved by

- **Reducing the pathogen levels**
- **Minimizing direct contact between the crops and the reclaimed wastewater**
- **Restricting the type of crops irrigated**

Based on various applications around the world, different treatment schemes can be adopted for safe irrigation of crops:

- **For restricted irrigation of forests, pastures, industrial crops, secondary treatment followed by detention in surface reservoirs can be sufficient**
- **Irrigation of canned fruits, vegetables for cooking and fruits with non-edible peels can be safe with tertiary effluents (activated sludge and seasonal detention or sand filtration)**
- **Unrestricted irrigation of edible crops requires more advanced treatment to ensure the microbial quality of the irrigation water. An example for such applications is tertiary treatment followed by soil aquifer treatment**

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