1stMediterranean Forum for PhD Students and Young Researchers
Designing Sustainable Agricultural and Food Production Systems under Global Changes in the Mediterranean

Reuse of reclaimed wastewater in a golf course in Agadir : Constraints and Perspectives

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1 INTRODUCTION

Souss Massa is a region suffering from water scarcity with a deficit of 260 Million m^3/year. About 90 to 95% of water is used for irrigation. Agadir which is its largest city, require aproximately 6. 92 Mm^3/year of water to irrigate its golf courses. At the same time, the city produces an average of 12.8 Mm^3/year of treated wastewater.

In order to overcome scarcity issues and capitalize on the reclaimed wastewater potential, the irrigation of a Ocean golf course with reclaimed wastewater have been initiated in 2010, in order to be evaluated and generalized later to other golf courses and green areas of the city.

The aim of this study is to describe the main impact of the reuse of reclaimed wastewater in this golf course, considering the quality of water and the management applied, and to suggest some practical solutions.

2 STUDY AREA

The Ocean golf course

- Climate: Arid.
- Rainfall: <250 mm/ year.
- Sunshine: 3,000 hours/ year.
- Evaporation: >2000 mm/year.
- Area: 90 ha (27 holes).
- Fairway turf: *Paspalum vaginatum.*
- Green turf: *Agrostis stolonifera*.
- Irrigation scheduling: based on field observations.

Reclaimed wastewater circuit

Treatment plant → Storage lake → Covered tank → Pumping station (Total outlet pressure 8.5 bars) → Filtration station (4 self-cleaning 200 µm strainers) → Sprinklers

Table 1: Soil texture in the Ocean Golf course

Fine sand (%)	Coarse sand (%)	Silt (%)	Clay (%)
52.2	45.9	1.4	0.8

3 MATERIALS AND METHODS

A diagnostic of the golf course was established in order to collect data about the study area, the soil type, turf grass species, water quality, and the irrigation and filtration system. As the diagnostic showed the occurrence of sprinkler's clogging issue, analyses of the clogging substance were performed to determine its constituents and the chemical reactions.

4 Results

Reclaimed wastewater Quality in the Ocean Golf course

Table 2 : Microbiological characteristics of reclaimed wastewater

Parameters	Units	Delivery pipeline	Limit values (WHO)
Fecal coliforms	CFU/100 ml	111	< 200
Vibrio cholerae	CFU/100 ml	Absence	Absence
Salmonella sp.	CFU/5L	Absence	Absence
Helminth eggs	Eggs/L	0.2	1

Table 3 : Physicochemical characteristics of reclaimed wastewater

Parameters	Units	Delivery pipeline	Sprinkler	Limits values (WHO)
pH		7,94	8,45	6,5 – 8
Conductivity	mS/cm at 25°C	3,35	3,49	3
Suspended Matter	mg/l	12	9	-
Bicarbonates	mg/l	813	790	518
Sodium	mg/l	460	446	-
Calcium	mg/l	200,4	201	-
Magnesium	mg/l	67	64,5	-
SAR	Meq/l	7.09	6.91	18
Potassium	mg/l	41	39,5	-
Phosphate	mg/l	0,74	1,27	-
Nitrates	mg/l	410	440	30
Chloride	mg/l	680	690	-
Sulfates	mg/l	122	124	-

Impacts of reclaimed wastewater on the irrigation system

The irrigation system clogging is a major problem in in the Ocean Golf course. Large amounts of brown deposits are formed in the storage ponds and in delivery pipelines. This causes a non uniformity of irrigation rates.

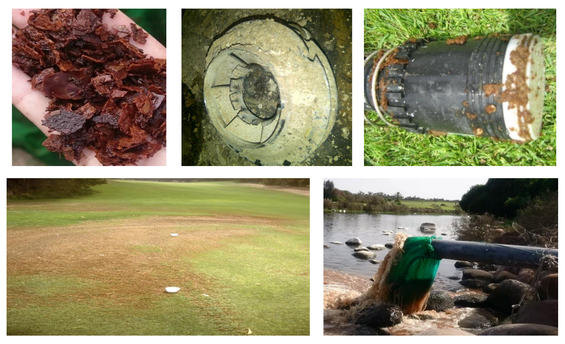

Table 4: Chemical composition of clogging matter

pH	Organic Matter (450°C)
8.6	18.72

Ca (%)	Na (%)	S (%)	Mg (%)	Fe (%)	K (%)	Cu (‰)	Pb (‰)	Zn (‰)
30.47	0.38	0.55	0.36	<0.1	<0.1	142	37	64

Notta bene: The chemical clogging is occuring according to the equation:

$$Ca^{2+} + 2\,HCO_3^- \rightarrow CaCO_3 \downarrow + H_2O + CO_2 \uparrow$$

Impacts of reclaimed wastewater on soil and turf

-Black layer issue: Excess Na in the water causes organic matter of colloidal size to migrate to this depth and start to seal the soil pores, eventually leading to black layer formation and causing anaerobic conditions. High sulfate concentrations in the water enhance the process.

-Water infiltration problems: Large amounts of Na, when not countered by sufficient Ca and Mg result in a reduction in water infiltration and percolation through the soil profile.

Table 4: Soil analysis

pH	OM	N	P_2O_5	K_2O
	g/kg	g/kg	g/kg	g/kg
9	20.8	0.83	0.86	0.06

MgO	CaO	Na	Fe	Mn	Zn	Cu
g/kg	g/kg	g/kg	mg/kg	mg/kg	mg/kg	mg/kg
0.31	7.49	0.19	9	20.8	0.83	0.86

5 Solutions

Clogging issues:

To solve clogging problems, three approaches should be taken into consideration.

-An efficient filtration system equipped with sand filters upstream the existing filtration system.

- Improvement of water quality before it reaches emitters, by acid or compounds that will inactivate metal cations and prevent them from precipitating.

-Water storage should be given great interest. Covered tanks have shown to be more efficient and having low cost maintenance, even if their installation costs are relatively high.

Salinity Issues

Techniques for controlling salinity that require relatively minor changes are more frequent irrigations, selection of more salt-tolerant crops, additional leaching, pre-plant irrigation, bed forming and seed placement. Alternatives that require significant changes in management are changing the irrigation method, altering the water supply, land-leveling, modifying the soil profile.

6 Conclusion

Interpretation of physical and chemical analysis revealed that the treated wastewater used in the Ocean Golf course is slightly alkaline, and showed high amounts of Calcium and Carbonates which may explain the large amounts of lime-like precipitated matter in the irrigation system. Results showed also that even if SAR of water is lower than problems occurred in soil. Based on these results, adequate management of wastewater irrigation should be done. If the clogging problem is solved and good gardening practices are established reclaimed wastewater reuse will be promoted at a more extended scale in Morocco.