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Evaluation of Wastewater Quality Treated by the Step of the City of Errachidia (Morocco)

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Abstract: The objective of this study is the physico-chemical and bacteriological characterisation of raw and purified wastewater from the WWTP of the city of Errachidia, Morocco, during the year 2020, in order to evaluate the effectiveness of wastewater treatment. of the wastewater treatment plant, of the aerated lagoon type, and see their reuse in irrigation. The average monthly results of the physico-chemical analyses of treated wastewater carried out from January to December 2020 are as follows: BOD5 = 94.45 mgo2/l; COD = 339.32 mgo2/l; SS = 87.67 mg/L. The results show compliance with the general limit values for the discharge of Moroccan surface water, which protects the environment. Thus, the bacteriological results show the presence of various germs with average annual values where faecal coliforms (CF) are 680 CFU/100 ml; total coliforms (CT) are 2810 UFC/100 and faecal streptococci are 46 UFC/100 ml, which remain below the limit values recommended by Moroccan irrigation standards (CF < 1000 UFC/100 ml), which allows their exploitation and their reuse in irrigation.

Key words: Treated wastewater, aerated lagoon, WWTP of the city of Errachidia, physico-chemical parameters, bacteriological parameters.

Introduction

Various sources of environmental pollution, especially in countries less aware of health risks, are caused by the growth of population, economy and urbanisation. Among these pollutions, wastewater is often discharged into the receiving environment without any treatment, according to OMS (2012) more than 80% of the world's wastewater is discharged into the environment without any treatment, thus leading to the degradation of ecosystems (terrestrial or aquatic) and the actual total volume of wastewater discharged into various water bodies present in the country is estimated at around 750 million m^3; 48% of this water is discharged into rivers and the natural environment and the rest towards the sea (Mandi and Ouazani, 2013). Also, urban wastewater contains nutrients usable by bacteria for their growth and development, thus having harmful consequences on human health (El Kettani and El Azzouzi, 2006). In addition, domestic wastewater contains a high percentage of organic matter and pathogenic microorganisms; in particular bacteria, viruses and parasites (Shakir et al., 2017), The city of Errachidia (Morocco) is no exception to this rule, hence the treatment of these discharges is necessary in order to fight against their harmful effects, and exploit this source of water available in abundance and continuously for reuse in irrigation, which prompted the municipality of the city to carry out a new treatment plant with an aerated lagoon in 2013, to apply to Moroccan standards and to increase the degree of purification.

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Materials and Methods

Study of the Environment

The study site chosen is the WWTP of the city of Errachidia (Figure 1) designed by the Moroccan National Drinking Water Office (ONEP). The city of Errachidia is located in the south-east of Morocco, 320 km south of the city of Meknes, and characterised by a dry climate. The wastewater treatment plant of the city of Errachidia is intended for the collective sanitation of the city's wastewater. The STEP is made up of 10 basins: 3 aerated basins, operate on the 1st floor, and the fourth aerated basin operates on the 2nd floor. The dimensions of these basins are identical and are 150 m long, 50 m wide and 4.5 m deep with a useful volume of 23,000 m^3 each. Apart from the second floor which has 5 aerators, all the others are equipped with 7 surface aerators with a power of 11 kW. The aeration time applied in the station is 11 hours/24 hours on the first floor per basin and 7 hours/24 hours on the second floor, 6 maturation basins which consist of 3 floors, each of which consists of 2 parallel basins. The maturation ponds have the following characteristics: 150 m long, 50 m wide, and 2 m deep with a useful volume of 11,325 m^3 each (Chaouki et al., 2014).

Parameters and Methods of Analysis

Physico-chemical and bacteriological analyses are carried out monthly on samples of raw and purified wastewater at the entrance and exit of the WWTP. The station's effluents were sampled during the year 2020, with the exception of April due to the confinement caused by Covid-19 which affected Morocco.

The analyses carried out are:

- Temperature.
- COD, BOD5 and MES

BOD5 is performed according to NF 1899-1 (AFNOR, 1998; Faïza et al., 2022; Jesus Villalobos et al., 2019). COD and MES are carried out, respectively, according to NF 90-101-2001/NM 03.7.54-2013, (Faïza et al., 2022; Soude et al., 2018) and NF in 872/2005 (Jesús Villalobos et al., 2019; Merhabi and Amine J. Halwani, 2019)

For bacteriological parameters:

Sampling is carried out under rigorous aseptic conditions.

Bacteriological parameters such as faecal coliforms; total coliforms and intestinal enterococci were performed respectively according to NM ISO 9308-1/2007, NM ISO 9308-1/2007 (Sadhana et al., 2021) and NM ISO 7899-2/2007 (Sadhana et al., 2021)

Assessment of the Abatement Rate

The abatement rate (t) in the treatment plant was evaluated using the following formula:

$$t = (V1\text{-}V2)*100$$

where $V1$ and $V2$ are the values of the pollution parameters (COD, BOD5 and MES), respectively, at the entrance and at the exit of the station. When t is greater than or equal to 70, the treatment is good, when t is between 50 and 70, the treatment is moderately good, and when t is less than 50, the treatment is bad or nil (DIRECTIVE 91/271/EEC).

Biodegradability Assessment

The evaluation of the biodegradability of the effluents was made on the basis of the COD/BOD5 ratio. If COD/BOD5<2, the effluent is easily biodegradable, 2<COD/BOD5<3, the effluent is biodegradable with selected strains and if COD/BOD5>3: the effluent is not biodegradable (Rodier et al., 2014).

Results and Discussion

The detailed results of the physico-chemical and bacteriological analyses of raw and treated wastewater from the WWTP of the city of Errachidia have been carried out from January to December 2020 and are presented in Table 1 and Figures 2 to 5.

Temperature (Figure 2)

There is no big difference between the temperature values of the wastewater at the inlet and the outlet of the STEP of the city of Errachidia, the temperature of the raw wastewater is between 14.9°C and 25°C, with an average of 20°C, Those of the treated wastewater are between 10°C and 26°C, with an average of 19°C (Table 1). These recorded temperatures are included in the range of limit values for the discharge of surface water from Morocco, which must be below 30°C, and in the range of Moroccan standards for the quality of water intended for irrigation (S.E.E.E-2007, Morocco).

Chemical Oxygen Demand (Figure 3)

The chemical oxygen demand makes it possible to assess the concentration of dissolved or suspended organic matter in the water, through the quantity of oxygen necessary for their total chemical oxidation (Rodier, 2016). The COD values at the inlet vary between 393.6 mg/L and 1368 mg/L during the year 2020. These values are lower than those found in 2013 in the same station for the months' of May, June and

Table 1: Physico-chemical parameters of raw and treated wastewater at the inlet and outlet of the treatment plant of Errachidia during the year 2020

Parameters Month		*T°C*	*TSS (mg /L)*	*COD (mgo2/l)*	*BOD5 (mgo2/l)*
January	Between	14.9	120	650	298
	Output	10	90	227	90
February	Between	18	188	792	360
	Output	17	100	240	88
March	Between	20	145	744	320
	Output	17	75	242	70
May	Between	25	156	922	391
	Output	26	86.5	202	125
June	Between	24	91.5	393.6	220
	Output	25	70	280	171
July	Between	25	413.5	930	460
	Output	25	47	203	121
August	Between	18.5	325	960	451
	Output	19	78	220	100
September	Between	19	140.5	721.3	364
	Output	19	98.14	464.6	142
October	Between	20	160	1131.3	129
	Output	20	100.5	498	25
November	Between	21	165	1368	251
	Output	20	105	608	31
December	Between	21	145	1114.6	393
	Output	20	104.5	548	76
Average	Output	19.81	86.78	339.32	94.45
surface or ground water discharge limit values (2018) Morocco.	Output	30	100	500	100

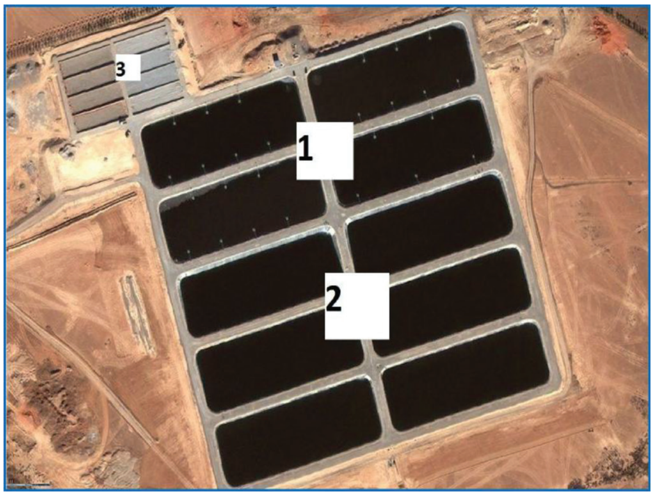

Figure 1: Synoptic diagram of the wastewater treatment plant of Errachidia

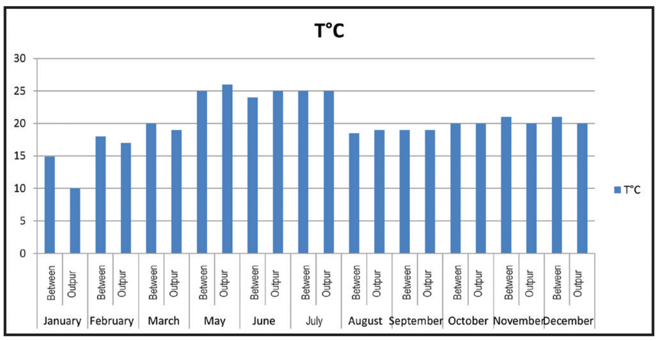

Figure 2: Variation of the average temperature values at the entrance and exit of the station.

July (Chaouki et al., 2014) and are more or less similar to those obtained in M'zar Agadir South which is 1433.7 mg/L as maximum value (Mansir et al., 2021). The values at the outlet vary between 202 mg/L and 608 mg/L with an average of 405 mg/L, these values at the

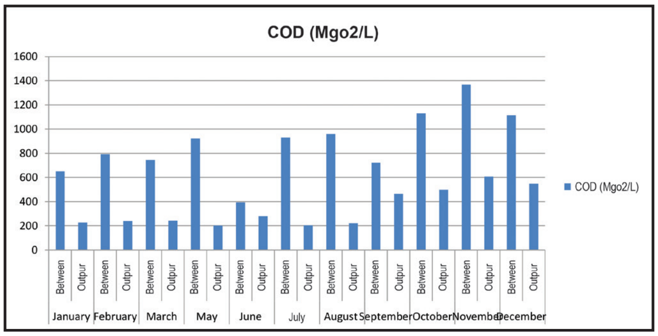

Figure 3 : Variation in average COD values at the plant outlet.

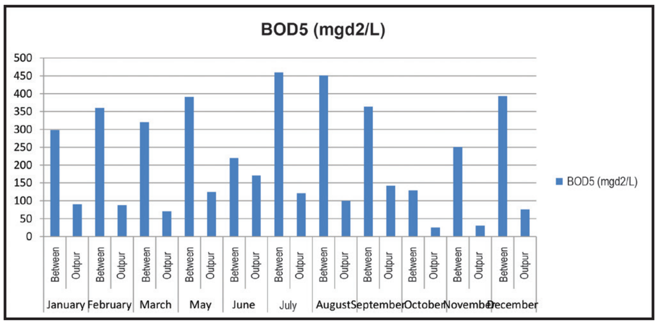

Figure 4: Variation of average BOD5 values at the inlet and outlet of the plant.

outlet of the STEP are lower than those found at the STEP of the city Dar El Gueddari, Morocco (Ayyach et al., 2016) from the month of January to August but from the month of September to December these COD values are higher than those of the output of STEP of the city Dar El Gueddari.

Using the results of Table 1, the COD/BOD5 ratio for the wastewater entering the WWTP is less than three (COD/BOD5<3) indicating biodegradable effluent while the COD/BOD5 ratio is higher to three (COD/BOD5 sup to 3) for the months of October to December, and therefore their biodegradability is difficult, this is due to the nature of the effluent resulting from the activity of small industrial units connected to the network of sanitation, same thing for the COD/BOD5 ratio at the exit of the STEP, These values show us an average reduction of the aerated basins with respect to carbon pollution, which reaches an average value of 66.4% which is lower than that found in 2013 (Chaouki et al., 2014), which is 83%. However, these COD values of the purified waters recorded remain in conformity with the general limit values for the discharge of superficial waters or depths of Morocco.

Biochemical Oxygen Demand (Figure 4)

The biochemical oxygen demand is the quantity of oxygen used for the degradation of decomposable and biodegradable organic matter by biochemical processes (Rodier, 2016). The concentrations of BOD5 at the entrance to the WWTP in the city of Errachidia (Morocco) vary between 129 mg/L and 460 mg/L, these values are similar to those found in Agadir, Morocco (Mansir et al., 2021) and lower than those found at the WWTP in the city of Dar El Gueddari, Morocco (Ayyach et al., 2016). The average values at the outlet vary between 25 mg/L and 171 mg/L with an average of 94.45 mg/L. These values at the outlet tell us about the best abatement of aerated pools with respect to carbon pollution and whose values can reach 70.47%, on the one hand. On the other hand, these recorded values of the BOD5 at the outlet comply with the general discharge limit values of Moroccan surface or underground water.

Suspended Solids (Figure 5)

All of the mineral and organic particles contained in wastewater represent suspended solids as well. Knowledge of the concentration of colloidal elements in wastewater is important to assess the effect of pollution on the aquatic ecosystem. The amount of suspended matter at the entrance varies between 91.5 mg/L and 413.5 mg/L, with an average of 186.31 mg/L, which remains lower than that found in 2014 (Chaouki et al., 2014) The concentration at the outlet varies between 47 mg/L and 104.5 mg/L, with an average of 86.78 mg/L. These SS values at the outlet of the STEP meet the general discharge limit values for Moroccan surface or groundwater.

The abatement rates of organic pollution parameters which are 70.47%, 60.21% and 44.02%, respectively, for BOD5, COD and SS indicate that the treatment efficiency of WWTP is better for BOD5, average for COD and low for suspended solids. The low reduction of suspended solids is explained by a malfunction of the

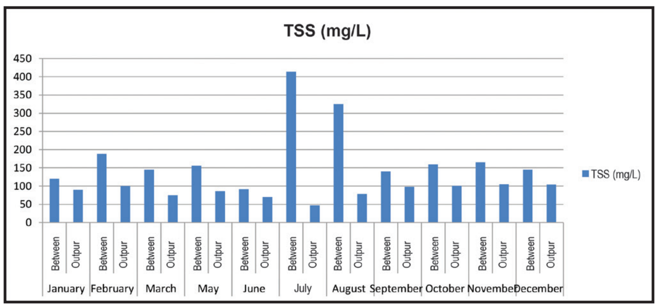

Figure 5: Variation of average TSS values at the inlet and outlet of the station.

Table 2: Abatement rate in % of raw and treated wastewater of the Errachidia wastewater treatment plant during the year 2020

Monthly reduction in %	*BOD5 (mg/L)*	*COD (mg/L)*	*TSS (mg/L)*
January	69.79	65.07	25
February	75.55	69.69	46.88
March	78.12	67.47	48.27
May	68,03	78.09	44.55
June	22,27	28,86	23.49
July	73.69	78.17	88.63
August	77.82	77.08	76
September	60.98	35.58	30.14
October	80.62	55.98	37.07
November	87.64	55.55	36.36
December	80.66	50.83	27.93
Abatement allowance and %	70.47	60.21	44.02

screening system which allows the waste to pass into the anaerobic basin. Similarly, the temperature plays a very important role in the reduction of the organic load. it is noted that if the temperature at the WWTP inlet increases, the organic load decreases at the WWTP outlet and vice versa, hence its importance in reducing the organic load. This importance of temperature in the reduction of the organic load is also highlighted in a study on the purification of wastewater by natural lagoons (Onifade, 2011). Thus the value of the average abatement rate for the winter season for BOD5 is 70.83%, and that of the summer season is 74.48%, likewise, the values of the average abatement rate for the winter season for SS is around 40.05%, then that of the summer season is 64.92% (Table 2), and therefore, the reduction rate for the summer season for BOD5 and SS is greater than that of the winter season. Hence the importance of temperature in reducing the organic load. Thus the reduction rates of the polluting load between raw effluents and treated effluents for COD, BOD5 and SS for the WWTP in the city of Errachidia which uses aerated lagoon treatment remain lower than those found in Mediona Casa Blanca, Morocco which globally exceeds 90% with a very efficient treatment system which is Biological Membrane Reactor (BMR) (Nahli et al., 2016)

Faecalgerms

The results of bacteriological analyses at the entrance to the treatment plant reveal the presence of germs indicating faecal contamination. The average total coliform (TC) load is around 56026.90 germs per 100 ml. For faecal coliforms (CF), the average values are 9080 germs per 100 ml. Faecal streptococci (SF) represent 1095 germs per 100 ml. The CF/SF ratio is greater than 1, which means that the faecal pollution of wastewater in the city of Errachidia is of human origin. According to Table 3, we note that the total coliforms at the outlet of the station vary between 17800 and 28 CFU/100 ml, while the faecal coliforms vary between 3700 and 16 CFU/100 ml with an average of 680 CFU/100 ml, and faecal streptococci vary between 180 CFU/100 ml and 5 CFU/100 ml, with an average of 46 CFU/100 ml. These values are comparable to those found in the wastewater treatment plant of the city of Agadir (Morocco) for filtered wastewater (CF) and (SF) for purified wastewater (Mansir et al., 2021) and do not exceed the Moroccan standard for water intended for irrigation, which allows us to deduce that also the treatment carried out in the finishing basins generates yields lower than the values required by the standards WHO and Moroccan (SEEE-2007) which is less than 1000 CFU per 100 ml. Also deduced from the values shown in Table 3 for total coliforms (CT) that the calculated purification efficiency of the winter season is 82.27% while that of the summer season is 97.92% where the effective role of temperature, thus for faecal coliforms (CF), the purification efficiency calculated for the winter season is 91.38% and that of the summer season is 90.80%, and therefore there is a slight difference between the two values of purification efficiency. These winter and summer purification efficiency calculated for total coliforms and faecal coliforms remain lower than those found in the WWTP of the city of Oujda (eastern Morocco) which is close to 100% (Rassam et al., 2012).

Conclusion

The evaluation of the physico-chemical and bacteriological parameters of the wastewater from the Errachidia treatment plant during the year 2020 shows that: The abatement yields with the aerated lagoon reached average values of 70.47 %, 60.21% and 44.02%, respectively, for BOD5, COD and SS and remain lower than those found in 2014 for the same station (82%, 83% and 88%) (Chaouki et al., 2014). As for faecal contamination indicator germs, their reduction is 92.51% for total coliforms; 94.98% for faecal coliforms and 95.79% for faecal streptococci (Table 3) as well.

Table 3: Average values of total coliforms; faecal and faecal streptococci of wastewater at the inlet and outlet of the treatment plant of Errachidia during the year 2020

Month		*Total coliform (CFU/100 ml*	*Fecal coliform (CFU/100 ml)*	*Fecal Streptococcus (CFU/100 ml)*
January	Between	1400	1200	1900
	Output	91	36	130
February	Between	95	44	89
	Output	63	23	36
March	Between	1400	950	280
	Output	360	130	180
May	Between	78	30	91
	Output	28	18	20
June	Between	150	73	190
	Output	120	52	110
July	Between	93	30	78
	Output	40	16	23
August	Between	980	14000	25
	Output	820	1200	5
September	Between	23600	1160	0
	Output	8900	180	0
October	Between	81500	3593	6300
	Output	1340	1820	0
November	Between	74000	14800	0
	Output	1350	310	0
December	Between	433000	64000	3100
	Output	17800	3700	0
Annual average Entrance station		56026,90	9080	1095
Annual average Output		2810	680	46
Average annual biodegradability in %.		94,98	92,51	95,79

The quality of the treated water from the station complies with the general limit values for the discharge of Moroccan surface or underground water. Aeration systems and the adaptation of micro-organisms to the degradation of organic matter. As a result, the quality of purified water allows its reuse in agriculture (Category A) according to the classification table of purified water intended for irrigation (S.E.E.E-2007, Morocco)). But it is advisable to adopt a tertiary treatment and disinfection to obtain treated water of acceptable microbiological quality for reuse in irrigation, allowing the protection of agricultural users and consumers of crops (WHO, 2012).

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