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Sustainable Concept to Recovering Industrial Wastewater Using Adjustable Green Resources †

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Abstract: In arid environments, specifically Africa, inadequate water sources have resulted in poor-quality water use in business and agricultural industries. This can also negatively impact the ecosystem along with the industry's water management. In solar power generation facilities, evaporating basins are usually used to release and store industrial contaminated wastewater. Examination of the environmental implications and concerns of this experience suggests such form of wastewater discharge to reduce industrial effluents' direct release into the environment. Unfortunately, this strategy could have far-reaching global environmental consequences and issues. In this research, we examined the evolution of the effluent's Physico-chemical characteristics over a long period using a methodological approach for a power station located in Morocco; the findings of this practical study show a significant increase in the physicochemical characteristics of the wastewater released in the evaporating basins, which might be interpreted by an increase in water pollution. The primary objective of this study is to examine wastewater recycling and the generation of treated water in a solar still utilizing renewable energy to minimize the environmental and ecological problems associated with wastewater discharged into evaporating basins.

Keywords: evaporating basins; wastewater; ecosystem; environment; physicochemical characteristics

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1. Introduction

The exploitation of resources is becoming increasingly destructive, and durable resource limitations, particularly in relation to freshwater, continue to be significant challenges in the twenty-first decade.

Evaporating basins (Figure 1) are ponds made of earth that are lined with a geomembrane and contain a volume of water that evaporates due mainly to exposure to full sunlight. The substances that are included in the mixtures begin to crystallize in the saline because of the evaporation of the surface water from the basins, which is then routinely recovered and disposed of as solid waste [1].

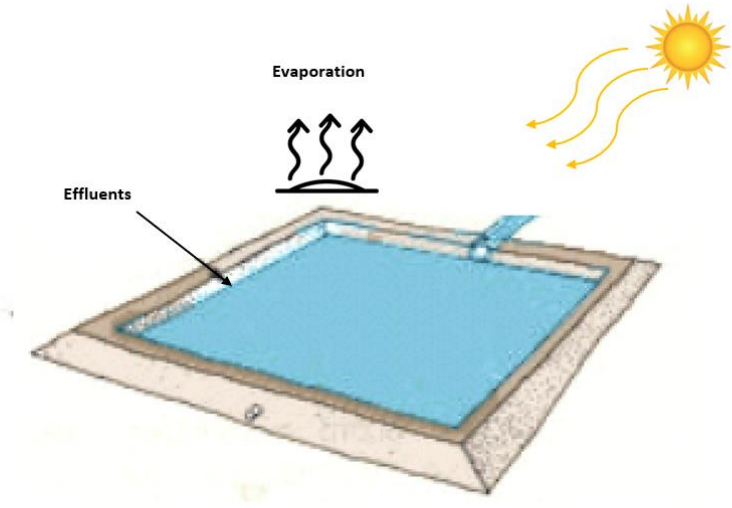

Figure 1. Evaporating Basin

However, there appear to be some disadvantages to employing evaporating basins, such as the need for large amounts of land once the evaporating rate has reduced or the dumping quantities are very high, and the necessity for such huge tracts when these situations arise [2].

Regardless of their numerous benefits, evaporating basins may cause a variety of environmental problems. It's possible, for illustration, that any industrial effluents from the evaporating basins could have devastating effects on the local ecosystem. Being open waterways, evaporating basins attract a variety of animals, which can lead to an increase in the mortality of some species if the collected effluent exceeds the permissible limits [3].

Wastewater treatment is crucial now because of the need to preserve the planet's precious resources. Many methods have been created to control effluent and reduce water pollution to reach this objective [4].

By analyzing the wastewater from a power plant in Morocco, we expect to demonstrate how serious an issue this has become for all factories, notably for water treatment factories that discharge their effluent into evaporation basins. This study examined the physicochemical factors that contribute to pollution in wastewater.

2. Material and Methods

2.1. Study Area

From November 2021 to October 2022, we obtained effluent samples from the evaporation basin of a Moroccan power plant, the idea is to make sure that we had a representative sample for a whole year.

2.2. Effluent Physicochemical Analysis

The Sigma SD900 Portable Sampler was used to collect the data set from the power plant between November 2021 and October 2022.

The Physico-chemical analyses of the wastewater were performed according to accepted and relevant techniques at an independent chemical analysis laboratory in Morocco.

The relevant Physico-chemical analyses were performed using the methods described below:

Total suspended solids (TSS), electrical conductivity (EC), and pH were measured in accordance with norms ISO 10523:2012, ISO 7888:2001, and EN 872:2013.

The organic pollutants' biochemical oxygen demand (BOD) and chemical oxygen demand (COD) were assessed using the norm 03.7.054 v 2013

Soluble sulphate (SO4) levels were measured in accordance with NM ISO/TR 896.

2.3. Regression Analysis

The least-squares regression method is used in statistics to make predictions about how control variable could change over time. When employing least-squares analysis, it is essential to focus on the optimum path in conjunction to all other keypoints. It is common practise for users to examine the relationship between the regression model and a set of probable variables by doing regression analysis (Equation 1) [5].

$$Y = ax + b \tag{1}$$

where Y = Dependent, x = Independent, a = Intercept and b = constant.

To better understand the relationships between the various effluent properties, a statistical study has been conducted. The statistical method of regression analysis is used to ascertain the strength and direction of the connection between the variables being investigated [6].

3. Results and Discussion

3.1. Physico-Chemical Results

The results from a year's length of Physico-chemical analysis on the power plant's wastewater are summarized in Table 1.

Table 1. Results of Physico-chemical evaluation.

Parameter	**unit**	**Limit**	**11/21**	**12/21**	**01/22**	**02/22**	**03/22**	**04/22**	**05/22**	**06/22**	**07/22**	**08/22**	**09/22**	**10/22**
pH	pH unit	5.5-9.5	8.1	7.9	7.6	7.9	8.0	7.5	7.6	8.1	8.1	7.1	7.7	8.0
EC	ms/cm	2.7	9	18	19	23	38	18	45	26	33	28	44	36
SO_4	mg/L	600	1800	1840	2320	1985	1300	3500	2900	4256	1987	2692	2569	4200
TSS	mg/L	100	102	79	105	129	153	304	215	116	98	197	203	171
COD	mg O2/L	500	356	620	560	519	614	652	498	516	563	578	452	512
BOD5	mg O2/L	100	95	120	95	115	118	103	142	109	98	102	115	124

Table 1 shows that the main effluent parameters (COD, BOD5, EC, SO4 and TSS) exceeded the maximum level imposed by Moroccan regulation for effluent released into the environment [7].

In May of 2022, the highest EC value measured was 45 ms/cm, which is much higher than the threshold value of 2.7 ms/cm.

In June of 2022, a maximum SO4 value of 4256 mg/L was measured, which is over the permissible limit of 600 mg/l.

In April 2022, the highest TSS measurement was 304 mg/L, which is above the allowable 100 mg/L.

In April 2022, the highest COD value was 652 mg O2/L, which is over the permissible 500 mg O2/L.

In May of 2022, the highest BOD5 measurement recorded was 142 mg O2/L, which is more than the permissible 100 mg O2/L.

3.2. Regression results

Descriptive and inferential statistics were employed in the regression study of effluent characteristics.

Table 2 displays the final square of the regression method developed utilizing statistically significant correlations between effluent properties.

Table 2. Regression's least square of effluent variables.

Y: Dependent	X: Independent	Correlation (r)	R^2	a	B (constant)	Regression Equation (Y = ax + b)
TSS	pH	−0.603	0.364	−127.88	1153.5	TSS= −127.88 pH +1153.5
TSS	SO4	0.415	0.172	0.028	81.68	TSS = 0.028 SO4 + 81.68
TSS	EC	0.314	0.098	1.81	105.13	TSS= 1.81 EC+ 105.13
BOD5	EC	0.649	0.422	0.79	88.91	BOD5= 0.79 EC + 88.91
COD	pH	−0.319	0.1023	−84.03	1192.2	COD= −84.03 pH+ 1192.2

Figure 2 shows linear connections between the following physicochemical properties of effluent:.

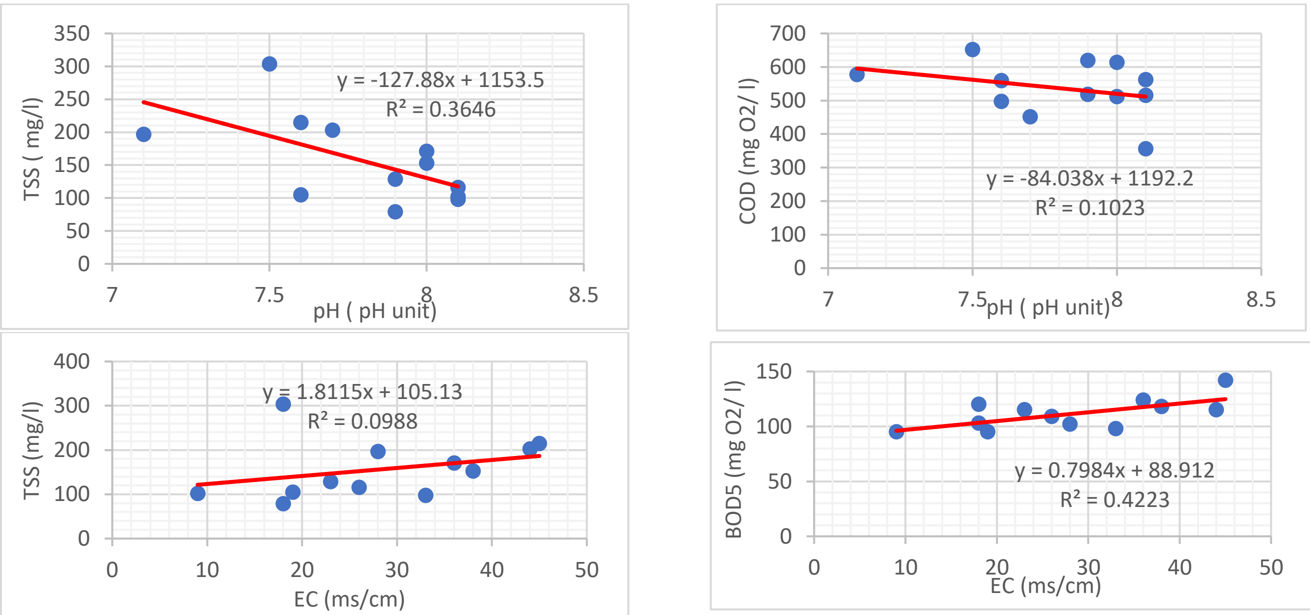

Figure 2. Regression linear plots for effluent variables.

Scatter plots showed positive linear relationships between total suspended solids (TSS) and SO4, total suspended solids (TSS) and EC, and BOD5 and EC. Nonetheless, both TSS and COD show negative linear relationships with ph.

By employing linear regression, we were able to determine the strength of those associations via the obtained R and R2 values.

The graph demonstrates a positive correlation between SO_4 and EC with TSS, and that increasing TSS likewise increases SO4 and EC. However, it demonstrates a negative correlation between TSS and COD with pH, and that increasing pH likewise decreases TSS and COD.

Storing of wastewater in the open air has a deleterious impact on the Physico-chemical and bacteriological properties of industrial effluents, as evidenced by an increase across various effluent properties that exceeds the maximum limits specified by international regulations. Since this phenomenon has the potential to cause ecological and environmental damage, it is imperative that every industry do a thorough environmental risk assessment to determine the most appropriate response [8].

According to the results of the physico-chemical analysis of the waste water kept in evaporation ponds, the primary external factors that have altered the physico-chemical characteristics of the wastewater over time include biological waste from species that are attracted to the surface of the water, dust, and the concentration of salt in the waste water as a result of evaporation.

Industrial power plants employed evaporation ponds to retain their effluent based on several criteria for power plant facilities. This approach is intended to prevent the direct discharge of wastewater into the environment. For power plants that still use water vapor as the primary input to power the steam turbine, this solution is used to compare the results from this research with those of other current research suggesting evaporation ponds as the ultimate wastewater retention and discharge.

Larger research might explore the viability of properly recycling effluent instead of its release into evaporation ponds. They could also look into the possibility of heating the wastewater using the solar collectors already in place for the power plant's process, then injecting the heated wastewater into a solar sill to create clean water which could be utilized by those solar power plants again, maximizing the surface water utilization to support the required sustainable development.

Considering that evaporation pond techniques are only used in arid, warm climates that are comparable to this study. Therefore, we may generalize the disadvantages of all worldwide companies that may release their effluents into evaporation basins.

This research and analysis bring us to the conclusion that discharging effluent into evaporating basins is not a viable solution due to the severe negative consequences it has on the environment and its resources.

Consequently, we propose that industries, especially power plants, use environmentally friendly strategies for recycling this effluent. As a result, this might help businesses justify charging higher rates for water consumption.

Among the most eco-friendly solutions for companies that utilize evaporation ponds is to install huge renewable solar stills; the benefit is conserving the environment as well as reusing wastewater. By doing so, the industry will be able to properly recycle its effluent while spending less on water.

Alternatively, the solar still can be warmed using solar panels that rely solely on sunshine, as shown in the following scheme (Figure 3) for connecting the solar still with evaporating basins. A clear sky all the time reflects a climate that is conducive to this technique.

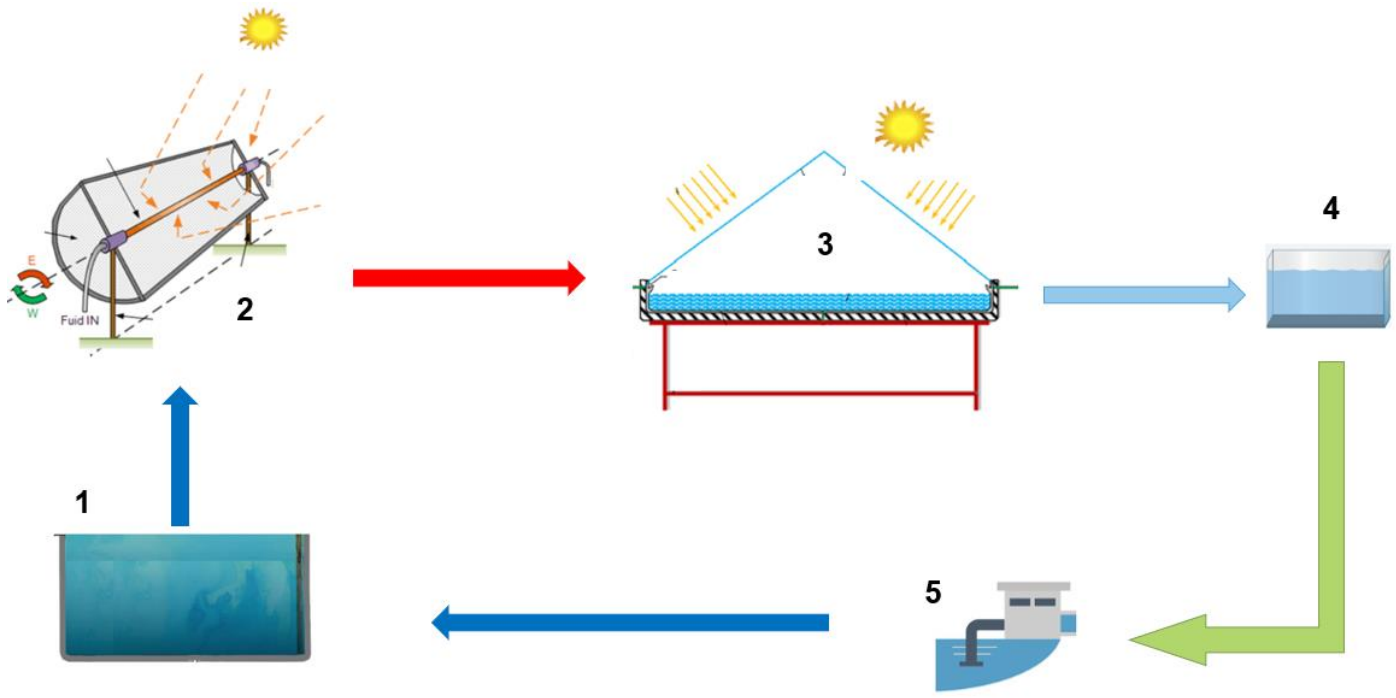

Figure 3. Recycling effluent proposed solution. (1) Effluent; (2) solar collector (3) solar still (4) Clean water (5) Process water.

4. Conclusions

This research, which examined the Physicochemical features of the effluents released by power plants, revealed that effluent quality worsened when exposed to stagnate or stored in evaporation basins. Consequently, several Physicochemical characteristics, such as electrical conductivity, total suspended particles, sulfate, and chemical and biological oxygen demand, rise substantially as a result of wastewater storage. As a result, there will be a rise in water contamination.

This study used data collected annually from a power plant's wastewater quality assessments to determine the most significant associations between most linked variables.

According to the findings, there is a correlation between the various physical and chemical characteristics of industrial effluent. In comparison, the values obtained for chemical and biological oxygen needs, electrical conductivity, Total Suspended Solids, and sulfates are all greater than the permissible limits for wastewater quality attributes in the research region.

The proposed eco-friendly option for businesses that utilize evaporation ponds is to install huge sustainable solar stills instead. This has the dual benefit of conserving the environment and reusing wastewater. Because of this, businesses will be able to save money on water bills while reusing wastewater.

References

1. Abdeljalil, A.; Nabil, S.; Rachid, M. Feasibility and Sustainability of Evaporation Ponds as Final Basins for Industrial Wastewater: Statistical Evaluation of Gross Parameters. *Desalination Water Treat.* **2022**, *257*, 41–54.
2. Ahmed, M.; Shayya, W.H.; Hoey, D.; Mahendran, A.; Morris, R.; Al-Handaly, J. Use of Evaporation Ponds for Brine Disposal in Desalination Plants. *Desalination* **2000**, *130*, 155–168.
3. Adam, A.; Saffaj, N.; Mamouni, R.; Baih, M. CHARACTERIZATION OF INDUSTRIAL WASTEWATER PHYSICO-CHEMICAL PROPERTIES. *Int. J. Tech. Phys. Probl. Eng.* 2022,14, 219–227
4. Lrhoul, H.; Assaoui, N.E.; Turki, H. Mapping of Water Research in Morocco: A Scientometric Analysis. *Materials Today: Proceedings* **2021**, *45*, 7321–7328.
5. Sow, A.; Traore, I.; Diallo, T.; Traore, M.; Ba, A. Comparison of Gaussian Process Regression, Partial Least Squares, Random Forest and Support Vector Machines for a near Infrared Calibration of Paracetamol Samples. *Results Chem.* **2022**, *4*, 100508.
6. Halconruy, H.; Marie, N. Kernel Selection in Nonparametric Regression. *Math. Methods Stat.* **2020**, *29*, 32–56.
7. Moroccan Limit-Values-of-Discharges. Available online: http://www.environnement.gov.ma/fr/78-cat1/1012-valeurs-limites-des-rejets (accessed on 2017).
8. Abdeljalil, A.; Nabil, S.; Rachid, M. Contribution to Developing an Environmental Emergency Response for Industrial Sites. *J. Environ. Agric. Stud.* **2021**, *2*, 97–102.