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PROCEEDING OF SCIENTIFIC EXTENDED ABSTRACTS

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Exploring the Potential of Increasing Crop Production Using Available Green Water in Sub-Saharan Africa

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Keywords: Food security, Green water, Remote sensing, Water-food-climate nexus.
CWW2023 Theme: 1

ABSTRACT

There are immense pressures on water and land resources to produce more crops for a growing population, a challenge that is aggravating with climate change [1]. As a result, a detrimental trend of converting natural land cover into cropland has emerged in sub-Saharan Africa (SSA) [2]. This change disrupts hydrological patterns, potentially leading to more extreme floods and droughts, which poses risks to African agriculture. Moreover, a further expansion of the cropland area must be avoided as it would entail increased use of blue water (surface and groundwater) for irrigation and infringe on valuable protected areas such as wetlands in SSA. To address these challenges and achieve sustainable agriculture while alleviating poverty and hunger, we need strategies that intensify and diversify farming practices [3] [4], offering potential benefits like increased crop production [5], reduced agricultural carbon footprint [6], and improved food security and livelihoods in Africa [7].

Against this background, this study advocates an efficient use of the prevailing green water (plant-available water stored in the soil) on the existing cropland areas in floodplain wetlands of SSA. The study developed a methodological framework to analyze the potential of increasing crop production using available green water beyond the wet season of rice cultivation in the Kilombero Floodplain in Tanzania (Ramsar site) that is representative for some 43 floodplain wetlands detected in SSA (Figure 1). In detail, the study quantified the water availability and variability for cultivating the dry season in floodplain wetlands in SSA. Our framework relies on open-source (remote sensing) gridded datasets to detect green water availability and variability patterns using existing and newly developed indices. The framework consisted of three steps: (i) land cover analysis, (ii) soi moisture condition and (iii) green water availability (Figure 2).

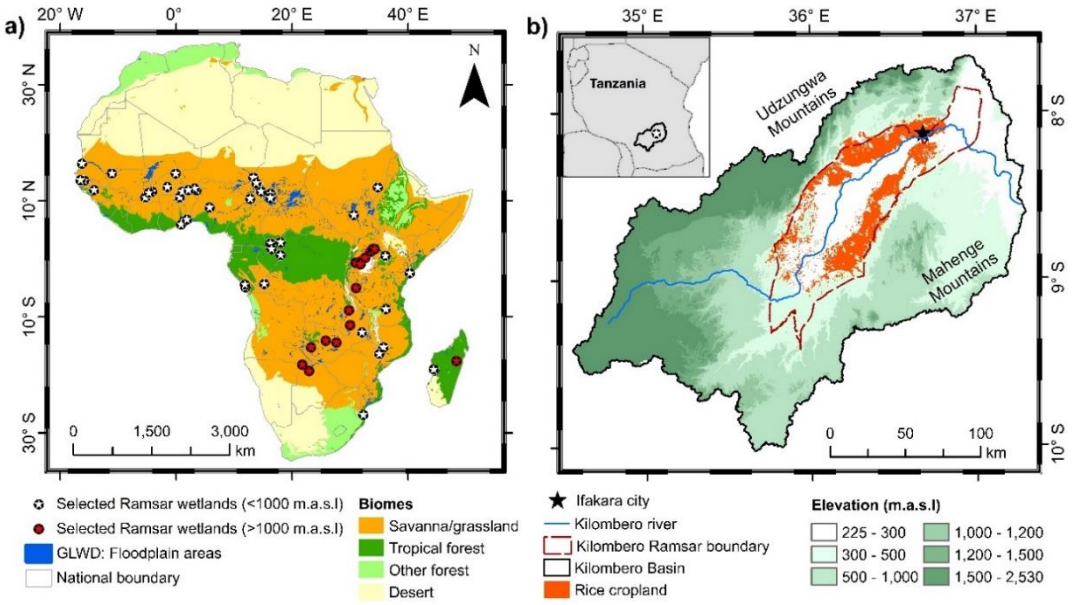

Figure 1. a) Detected seasonal floodplain wetlands in sub-Saharan Africa that are designated as Ramsar sites (https://rsis.ramsar.org/; GLWD [8]; biomes (adapted from [9]. b) Kilombero Basin (delineated using the SRTM elevation: https://srtm.csi.cgiar.org/srtmdata/); Kilombero Ramsar boundary: https://www.protectedplanet.net/en.

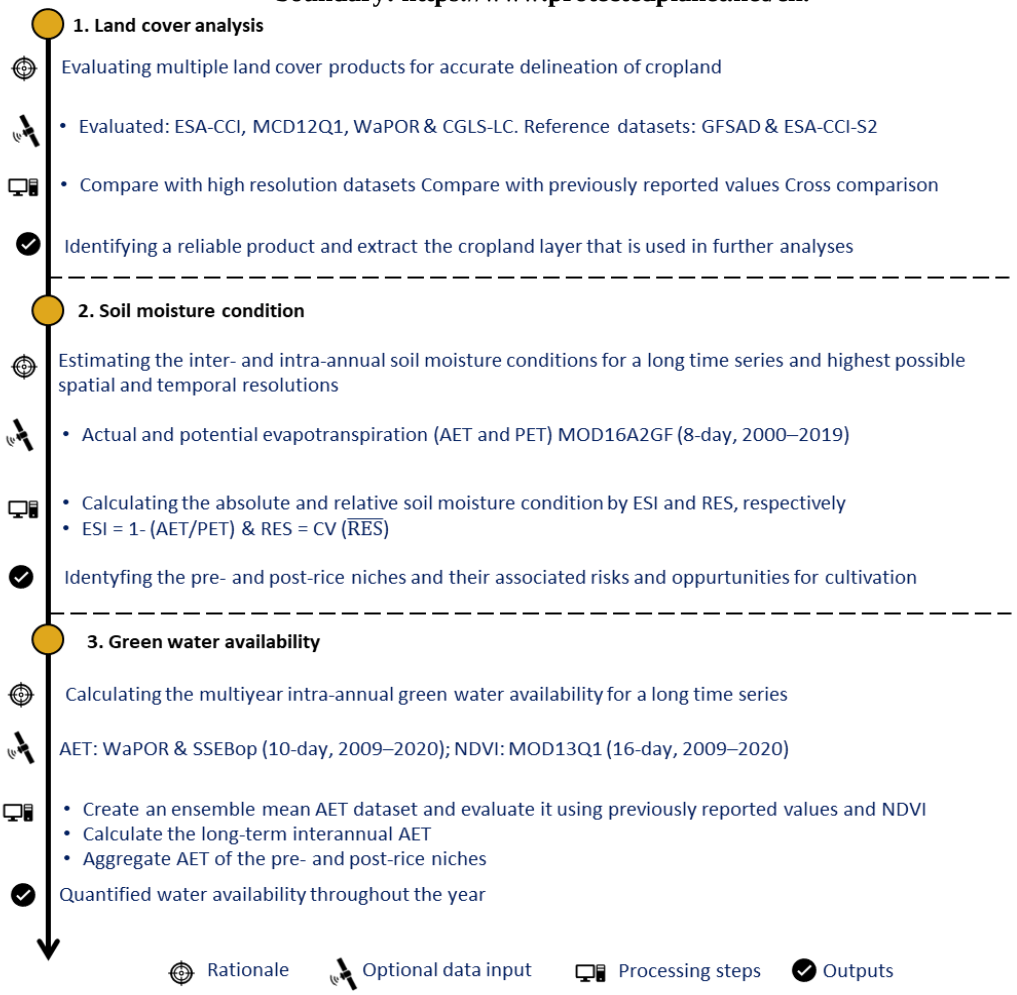

Figure 2. The developed framework including the main steps, objectives, data used, procedure and output.

The results demonstrated the substantial potential for increasing crop production using available green water. In particular, the study found that more than 50% (at least 1452 km^2) of cropland areas in Kilombero Floodplain can be cultivated using green water stored in the soil during the dry season (before and after rice cultivation) and thus extending the cropping season by about 135 days. The pre-rice window tends to be longer (~70 days with average evapotranspiration of 2–4 mm/day) but also more variable (inter-annual variability >30%) than the post-rice window (~65 days with average evapotranspiration 1–3 mm/day, inter-annual variability <15%). These findings show the large potential for cultivating short-cycled crops beyond the rice-growing period, such as green manure, vegetables, maize, and forage legumes, by shifting a portion of the nonproductive AET flows (i.e., soil evaporation) to productive flows in form of crop transpiration. Such potential permits to maximize the agricultural potential as well as farmers' livelihoods and resilience. A wider application of the developed approach in this study can help identifying opportunities and guiding interventions and investments towards establishing cropping intensification and diversification practices using green water resources while simultaneously reducing pressures on the already-scarce blue water resources in Africa. The framework and data used are fully transferable and can be applied to other regions. This abstract is based on a recently published article [10].

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Water Productivity for Date and Olive in Palestine

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Key Words: Biophysical, Date Palm, Economic, Olive, Water Productivity
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ABSTRACT

Palestine is a prime example of a country with severe water shortages, whereby a diverse set of socio-economic and political challenges resulting from decades of military occupation. Two sites were chosen to study the biophysical and economic water productivity for two crops that are considered pillars of the agricultural sector in Palestine. The first one was the Jericho area in Jordan Valley for date palm groves and the second was Beit Liqya in Ramallah for olive orchards. Specific questionnaires for this purpose were prepared and filled and data, information, and soil samples were collected and analyzed. By using the collected data, ETo and ETc were both estimated, taking Kc, ER, GC%, and LR into consideration. By using the collected data of production and gross revenue, WPs were then estimated for date palms and olive trees.

The date palm sector is characterized by being a very well-organized economic sector with most of the farms being large, well organized and well managed. The average biophysical WP_{ET} was 0.44 kg/m^3 while the economic WP_{ET} 1.32 USD/m^3. Even though there were some contradictions and incompatible information provided by farmers, the WP_{IRR} in the nine studied farms was estimated to be 0.67 kg/m^3 and USD 1.96/m^3, with 127 m^3 of water consumed as ETc and 91 m^3 of water being applied per tree. Even so, it was still concluded that water has been used efficiently in these farms.

It can be concluded that the highest biophysical WP_{IRR} was for date palm groves irrigated with fresh spring water (0.71 kg/m^3) followed by irrigation with brackish water (0.67 kg/m^3) and treated wastewater (TWW) (0.63 kg/m^3). For economic WP_{IRR}, the highest values were estimated in groves irrigated with TWW (USD 2.41/m^3) followed by groves irrigated by well water (USD 1.99/m^3), with the lowest estimated from freshwater irrigation (USD 1.62/m^3).

Although intensive date palm cultivation in the Jericho area is generating important social and economic advances, the future scenarios suggest extreme caution on the wide adoption of simplified and biodiversity-poor models (Russo *et al*., 2018).

For olive trees, it was very clear that increasing the biophysical and economic WP by moving towards supplementary irrigation (SI) practices could be one of the best solutions for developing this sector, while also driving the development of other tools and services related to this crop. The addition of 12 cm of water per dunum as supplementary irrigation could improve biophysical WP for olive fruit in the off-year from 0.22 kg/m^3 in the rainfed system to 11.9 kg for each m^3 added in SI. With the same trend, this value can be increased from 0.29

kg/m^3 to 15.3 kg/m^3 in on-year yield. WP_{IRR} was estimated by considering the difference in production between rainfed trees and trees irrigated by SI as the numerator and the quantity of water added in SI as the denominator.

The assessment of WP for different crops and different patterns can be used as a tool to reform the policies around prioritization, investment and water utilization; answering any questions regarding where to motivate the investment; how best to reallocate available water resources in various economic sectors; how to quantify the benefits of change in introducing new crops, or encouraging current crop systems; and how to help the extension services to be updated and developed. The results will also effectively contribute to the adoption of new practices to increase water efficiency and productivity and then achieving the SDG goals in Palestine.

Discussion and Main Results:

WP is generally defined as the crop yield, or the economic value of a crop per cubic metre of water consumption (ETc), including both green water (water from precipitation) and blue water (diverted water from water systems) for irrigated areas (Cai and Rosegrant, 2003). The biophysical and economic WPs were estimated for the nine farms planted with mature date palms (more than seven years). As shown in Table 1, the biophysical WP ranged from 0.33 kg to 0.61 kg of dates/m^3, while the economic WP ranged between ILS 2.6 to ILS 6.6 for each m^3 of water. The lowest values of WPs in JEFA9 were due to the farm being neglected for a long time.

Table 1. Biophysical and economic WP for date palms planted in Jericho (JV)

Code no.	Production per tree	Revenue per tree	Plant density	Monthly ETc/tree	Biophysical WP_{ET}	Economic WP_{ET}	Economic WP_{ET}	Biophysical WP_{IRR}	Economic WP_{IRR}	Economic WP_{IRR}
	kg/tree	ILS/tree	tree/du	m^3/tree	kg/m^3	ILS/m^3	USD/m^3	kg/m^3	ILS/m^3	USD/m^3
JEFA1	57.5	518	14	139	0.41	3.7	1.15	0.55	4.9	1.51
JEFA2	65	650	14	142	0.46	4.6	1.41	0.82	8.2	2.52
JEFA3	55	825	16	126	0.44	6.6	2.02	0.72	10.7	3.31
JEFA4	55	330	16	126	0.44	2.6	0.81	1.16	7.0	2.14
JEFA5	85	808	14	139	0.61	5.8	1.79	0.64	6.1	1.88
JEFA6	70	630	16	126	0.56	5.0	1.54	0.59	5.3	1.64
JEFA7	50	500	16	126	0.40	4.0	1.22	0.63	6.3	1.93
JEFA8	40	360	18	111	0.36	3.3	1.00	0.59	5.3	1.64
JEFA9	36	342	18	111	0.33	3.1	0.95	0.36	3.5	1.07
Average	**57**			**127**	**0.44**	**4.29**	**1.32**	**0.67**	**6.37**	**1.96**

It can be concluded that biophysical and economic WPs for real consumed water as crop evapotranspiration (WP_{ET}) is always lower than WPs for irrigation water productivity (WP_{IRR}). WP for olive trees is generally defined as crop yield per cubic metre of water consumption (ETc), including green water (effective rainfall) for rain-fed areas and both green water and blue water (blue water being added water by supplementary irrigation).

In Table 2, the biophysical and economic WP_{ET} in olive trees were estimated for two consecutive years: 2019–2021 (on year) and 2020–2021 (off year). Both WPs in the on-year were higher than that in an off-year.

Table 2. WP for Olive Trees with Rainfed Crop Pattern

Olive crop pattern	Code no.	Production per dunum 2019–2020	Production per dunum 2020-2021	ETc	SI	Total water	Biophysical WP_{ET} 2019–2020	Biophysical WP_{ET} 2020–2021	Economic WP_{ET} 2019–2020	Economic WP_{ET} 2020–2021
		kg/du	kg/du	mm	mm	mm	kg/mm	kg/mm	ILS/mm	ILS/mm
Rainfed olive orchards	RAFA4	174	56	426.1	0	426	0.41	0.1	2.4	0.6
	RAFA6	250	125	426.1	0	426	0.59	0.3	3.5	0.5
	RAFA7	167	83	426.1	0	426	0.39	0.2	3.5	1.8
	RAFA9	0	175	426.1	0	426	0.00	0.4	0.0	1.8
	RAFA10	27	36	426.1	0	426	0.06	0.1	0.8	1.3
	Average						**0.29**	**0.22**	**2.07**	**1.22**

Table 3. WP for Supplementary Irrigation

Comparing rainfed and irrigated farms	Season 2019–2020 (on-year, or Masya'a)					Season 2020–2021 (off-year, or Shalatouneh)				
	Average annual fruit production	Average annual olive oil production	Average revenue from oil	Average revenue from oil	Amount of SI water	Average annual fruit production	Average annual olive oil production	Average revenue from oil	Average revenue from oil	Amount of SI water
	kg/du	kg/du	ILS/du	USD/du	m^3	kg/du	kg/du	ILS/du	USD/du	m^3
Farms with SI	331	77	2 319	713	12	248	59	1 765	543	12
Rainfed farms	148	36	1 121	345	0	105	22	715	220	0
Difference	184	42	1 198	369	12	143	37	1 050	323	12
WP_{IRR}	**15.3**	**3.5**	**99.8**	**30.7**		**11.9**	**3.1**	**87.5**	**26.9**	

In Table 3, the biophysical and economic WP_{IRR} were calculated for 2019–2021 (on year) and 2020–2021 (off year). For both years, the biophysical irrigation WP_{IRR} numerators were the differences in the production of olives and olive oil between rainfed and supplementary irrigation crop patterns, while in the economic WP_{IRR}, the differences in gross revenue of olive oil production between rainfed and supplementary irrigation crop pattern were considered. The comparison of yields and revenue between supplementary irrigation with traditional rainfed patterns shows that the benefits of the application of a small quantity of water were very significant.

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Visualizing and Quantifying the Effect of Rigid Bank Weeds on the Flow Parameters

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Keywords: Bank weeds, Density, Empirical equations, Velocity distribution, Water profile.
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ABSTRACT

Aquatic weeds exist in waterways in different forms, which can be classified according to their position as submerged, emergent, and bank weeds, Galema 2009 [1]. Weeds can also be classified according to their flexibility as rigid and flexible weeds [1]. The current research was focused on the rigid bank weeds. Recently researchers found out that the effect of ditch-bank weeds is not similar to the effects of weeds on channel bed. Where ditch-bank weeds promote geomorphic stability through increasing flow resistance and therefore, reducing near-bank flow velocity [2]. So, the concept of ditch-bank weeds and their effects on main channel flow properties must be developed and several more studies should be carried out to understand and clarify the effect of ditch-bank weeds on flow characteristics. Hopkinson et al. and Valyrakis et al. [3,4], studied experimentally the effect of bank weed's stiffness on velocity distribution. The result concluded that, for all cases, the velocity near the bank weeds was lower than the velocity in the middle of the channel. Hirschowitz and James [5] physically studied the effect of sided flexible vegetation on the water surface profile and concluded that water levels decreased within vegetation compared to the smooth case.

Most of the previous studies were focused on visualizing the effect of aquatic bank weeds on the velocity and water depths, without significant considerations on quantifying these visualizations for different vegetation densities and Froude numbers. Therefore, the motivation of the current study is to experimentally explore the effect of rigid bank weeds density on the velocity distributions and changes in water surface profile at different flow conditions. The experiments were done considering different Froude numbers under subcritical flow conditions for clear water.

The experimental runs were carried out using a reinforced concrete trapezoidal cross-section flume of a re-circulating water supply system. The main part of the flume has dimensions of 16.22 m length, 0.60 m bed width, a maximum depth of 0.42 m, and 1:1 side slope. The water depth in the flume was controlled using a tailgate at the end of the flume. For all tests, with and without vegetation, a fixed set of 4 discharge rates each with 3 water depths was used. The rigid ditch bank weeds stem was represented by 3 mm diameter steel rods set in a staggered grid pattern with a fixed reach length of 4.00 m located at the middle of the flume.

They were distributed with three center spaces (25, 50, and 75 mm) in both the longitudinal and transverse directions and distributed to simulate unilateral and bilateral infestation.

Water depths were measured every 0.50 m along the canal centerline using an ultrasonic level meter (Sondar) in all runs. Three velocity profiles were measured – upstream and downstream of, and within the vegetated reach – using a Vectrino 3-D water velocity sensor.

The measuring water surface profile and vertical velocity profiles were plotted for different weed densities and arrangements, and the results concluded that, for all weed distribution and configuration, the water profile takes the same attitude. Where the water level rose upstream the weedy reach, then, it lowered within it and gradually backed to the normal depth downstream the vegetated reach, as shown in Figure 1.

For all cases, it was observed that the velocity profile as a ratio between vegetation velocity (V) and the smooth velocity (u), (V/u) is sigmoid, i.e. that the maximum velocity in the center of the weedy reach occurred at the lower half of the water column for $W/h \leq 3$ "where W/h is the ratio between the channel width and the flow height". Where the presence of bank weeds produces a secondary flow that increased the velocity near the channel bed. These results were agreed with the findings of [6-8]. Table 1 represents the ratio between the maximum velocity (V_{max}) in the case of weeds and the maximum velocity in the smooth case (u_{max}).

Table 1. (V_{max}) / (u_{max}) Ratio for Study Cases.

Arrangement	Density	Velocity position		
		Upstream	Middle	Downstream
Bilateral infestation	High	9 %	50 %	43 %
	Medium	4 %	32 %	28 %
	Low	2 %	27 %	24 %
Unilateral infestation	High	4 %	24 %	17 %
	Medium	2 %	12 %	9 %
	Low	1.4 %	12 %	8 %

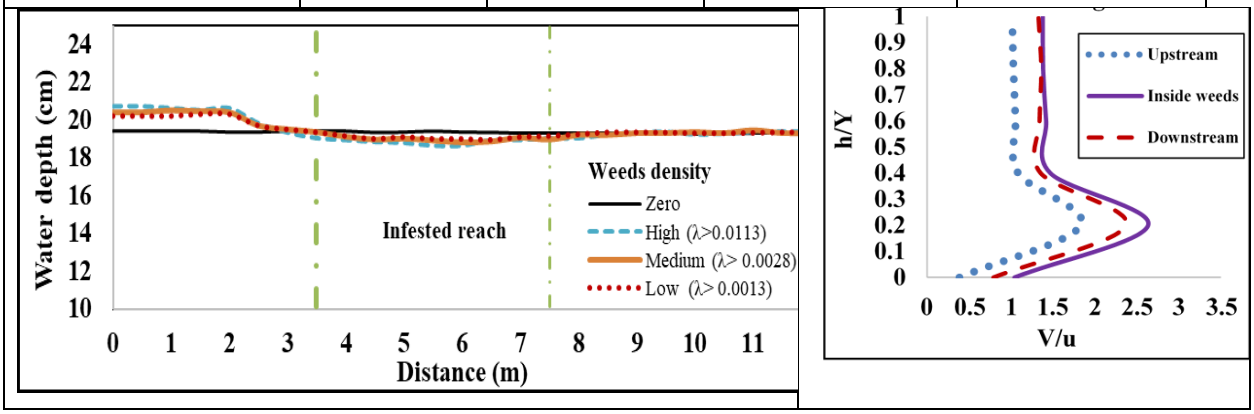

Figure 1. Sample for water surface profile and vertical velocity profile results

Under the experimental work limitations, Vegetation density (λ) ranged between 0.013and 0.0013/m and Froude number (Fr_o) ranged from 0.11 to 0.30, six empirical equations were developed to assess and understand the impact of aquatic bank weed density on the change

in velocities and water depth. These equations can be contributed to manage and rehabilitate the open channel and give a chance to do them in minimum time and cost.

According to Afzalimehr and Dey [6], this research presented the effect of bank weeds on the flow parameters for narrow channels, where the ratio between the channel width and the height is less than 5. So it is recommended that further studies to investigate the effect of bank weeds on flow parameters in wide channels. Also, it is advised to study the effect of sparse distribution and study denser vegetation conditions.

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Applying Various Indices to Evaluate the Effects of Abu Zaabal Fertilizers Company on the Zooplankton Biodiversity and Water Quality of Ismailia Canal, Egypt.

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Keywords: Water quality, Indices, CCME WQI, CCA, Zooplankton community structure, Zooplankton biodiversity, Ismailia Canal.
CWW2023 Theme: 1.

ABSTRACT

One of the most beneficial water streams in Egypt is Ismailia Canal. Despite its significance, numerous factories often dump their trash on it, resulting in a drastic decrease in its water quality and fauna. Therefore, the purpose of this study was to evaluate the negative impact that Abu Zaabal Fertilisers Company had on the community structure, zooplankton biodiversity, and water quality of Ismailia Canal. Four stations have been selected (a reference site and three sites in front of the company). Each station was subjected to the Canadian Water Quality Index (CCME WQI) and the metal index (MI) in order to determine which station was the canal's primary source of contamination. In order to assess how the drainage water from the Abu Zaabal Company affected the zooplankton biodiversity and density in the canal, each station's zooplankton community structure was examined and Shannon-Weiner biodiversity index (H') was calculated. Furthermore, the Canonical Correspondence Analysis (CCA), a multivariate analysis, was applied in order to be aware of the environmental variables that drive the composition of the zooplankton community structure. The Bray-Curtiz similarity index was determined and computed by Primer 5 to explore the similarity degree between the stations under investigation in accordance with the zooplankton community structure. According to the CCME WQI values, stations 3 and 4 revealed marginal water quality, which is indicative of the destructive impact of the Abu Zaabal Fertilisers Company. On the other hand, the metal index (MI) was determined for each station, and the results showed that there was no metal pollution in the Ismailia Canal area under study. Concerning zooplankton population, the total density was of average of 598854 ind./m^3, and composed of 19 zooplankton species belonging to the genera Rotifera, Cladocera, Copepoda, and Nematoda. The highest zooplankton population density was recorded in station 4 and these results indicated that there is organic pollution with a high degree of eutrophication especially in station 4 as a result of Abu Zaabal Fertilizers Company effluents. Rotifera was the most predominant group where it represented 97.05% of the total zooplankton density. The current investigation revealed seventeen distinct rotifer taxa. *Keratella cochlearis* was the species with the greatest density of populations, followed by

Polyarthra vulgaris and *Brachionus calyciflorus* with approximately 45.21%, 22.09%, and 11.10% of the overall rotifer abundance, respectively. These findings are similar to those of Nassif [1], who identified 22 species of rotifers in the Ismailia Canal in 2010, with the predominance of *Polyarthra vulgaris*, *Collotheca pelgica*, *Trichocerca pusilla*, *Keratella cochlearis*, and *Brachionus calyciflorus*. According to El-Shabrawy and Khalifa [2] and Mola *et al.* [3], the dominance of eutrophic indicators like *Brachionus calyciflorus*, *Polyarthra vulgaris*, and *Keratella cochlearis* explained why this section of the Ismailia Canal is so eutrophic and polluted. Furthermore, Abdel Aziz and Aboul Ezz [4] pointed out that most of the rotifers are represented as polysaprobic organisms that inhabit a highly polluted ecosystem. Moreover, the CCA indicated a strong relationship between BOD, COD, and Al with *Keratella tropica*, *Keratella valga*, *Brachionus calyciflorus*, and *Brachionus quadridentatus*. Obviously, SO_4 was the most driving factor for *Bosmina longirostrus*, *Leacane lunaris*, and *Lepadella* sp. distribution, while PO_4 was the driving variable for Nauplius larvae (Figure 1). The similarity dendrogram illustrated that station 4 has a unique zooplankton community that has developed due to the eutrophication brought on by the effluents of the Abu Zaabal Fertilisers Company as a downstream station (Figure 2). It was evident that the drainage water from the Abu Zaabal Fertilisers Company made stations 2 and 3 to have the highest similarity value. Although the diversity index (H') revealed that station 3 had the highest value (H'= 1.8), the number of species was the fewest with special abundance of the organic matter bio-indicator species. Thus, it was possible to draw the conclusion that the company's discharge had a negative impact on the zooplankton community's structure, density, and abundance which in turn affect the fish feeding habits. That's why mandatory laws had to be enforced to mitigate the canal's deterioration and improve its quality.

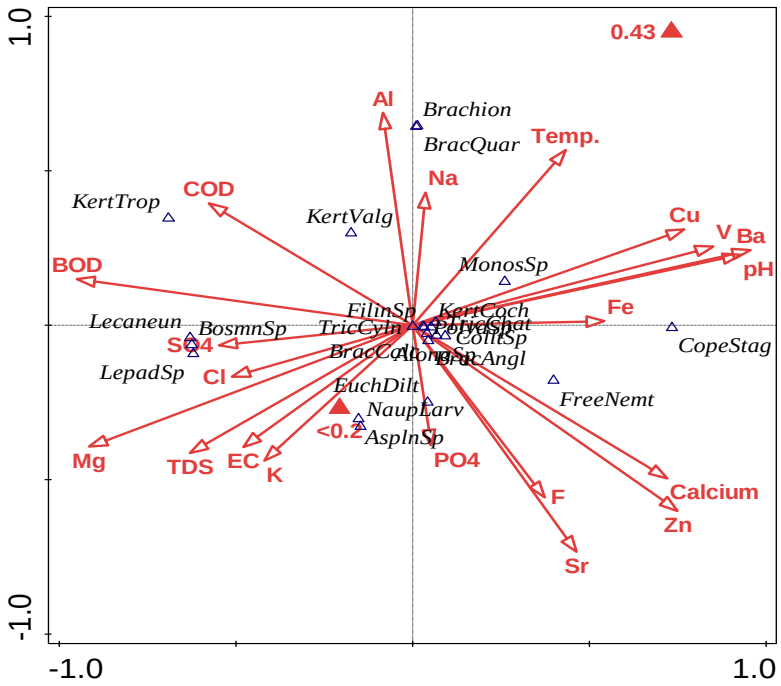

Figure 1. Biplot of Canonical Correspondence Analysis (CCA) representing the relationships between the zooplankton species and the physico-chemical properties in Ismailia Canal surface water.

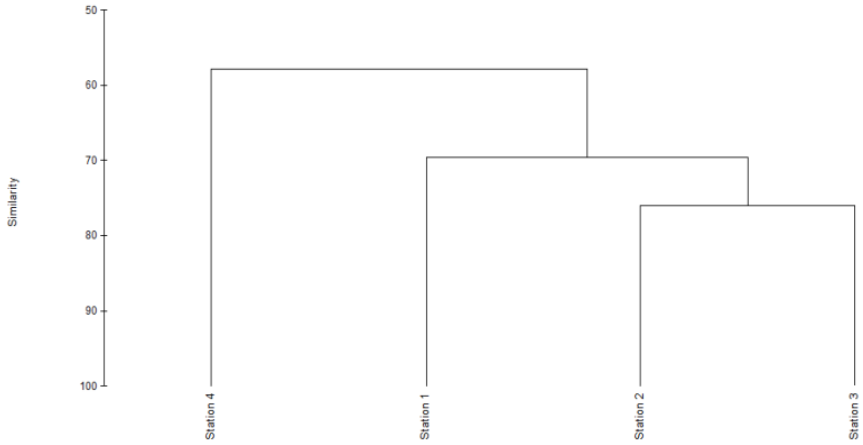

Figure 2. Dendrogram showing similarity among the four studied stations in Ismailia Canal according to zooplankton community structure.

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Growth response of Kale (*Brassica Oleracea*) and Nile Tilapia (*Oreochromis Niloticus*) under Saline Aqua-Sandponics-Vegeculture System

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Keywords: salinity; kale; sandponics; irrigation; sustainability.
CWW2023 Theme: 1

ABSTRACT

Salinity and freshwater scarcity are significant challenges affecting agriculture production worldwide. Sustaining food production in arid and semi-arid regions requires innovative, efficient, and low-cost technologies. Integrated aqua-vegeculture systems (IAVS) are promising technologies for cultivating vegetable crops and rearing fish and in a closed-loop system. The system utilizes fish effluents as crop fertilizers and recycles water for increased productivity. Hence, the current study aimed to investigate the response and productivity of kale (*Brassica oleracea L.*) grown at different brackish water salinities in an IAVS. The greenhouse experiment followed a completely randomized design with three salinity variants (i.e., 3000, 6000, and 9000 ppm) and control (freshwater, 400 ppm) with four replicates per treatment.

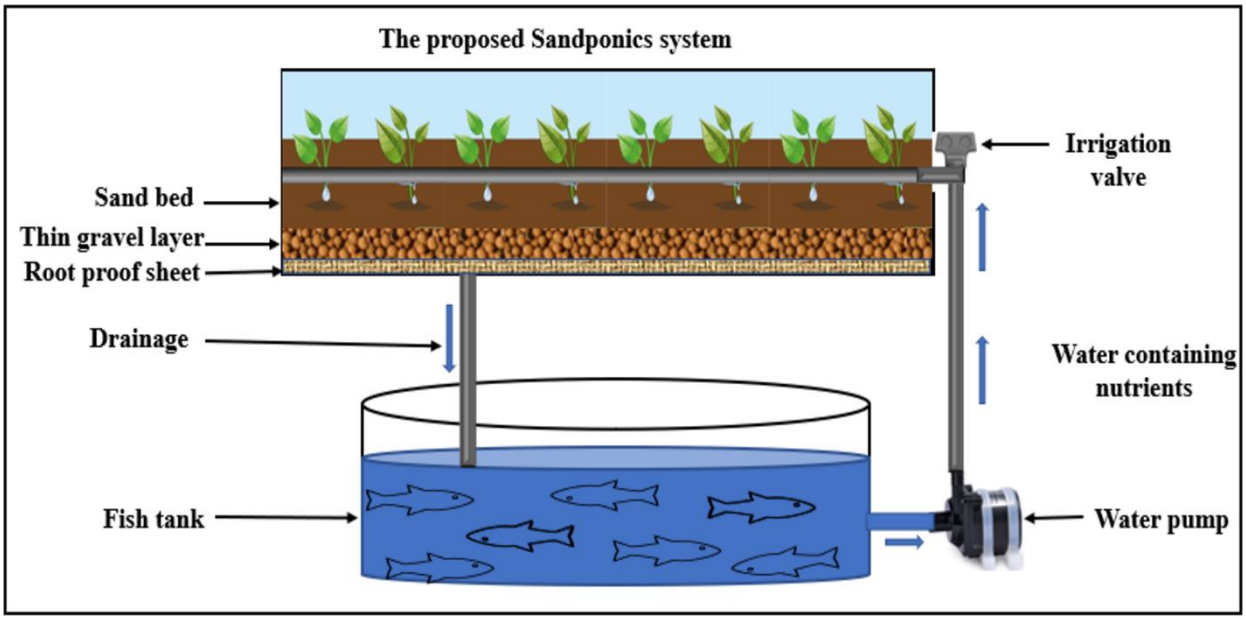

Figure 1. Schematic design of the experimental layout.

The study results indicated that kale grown in a greenhouse could tolerate salinity levels of up to 6000 ppm without significantly compromising the plants' growth, yield, and nutritional composition of leaves.

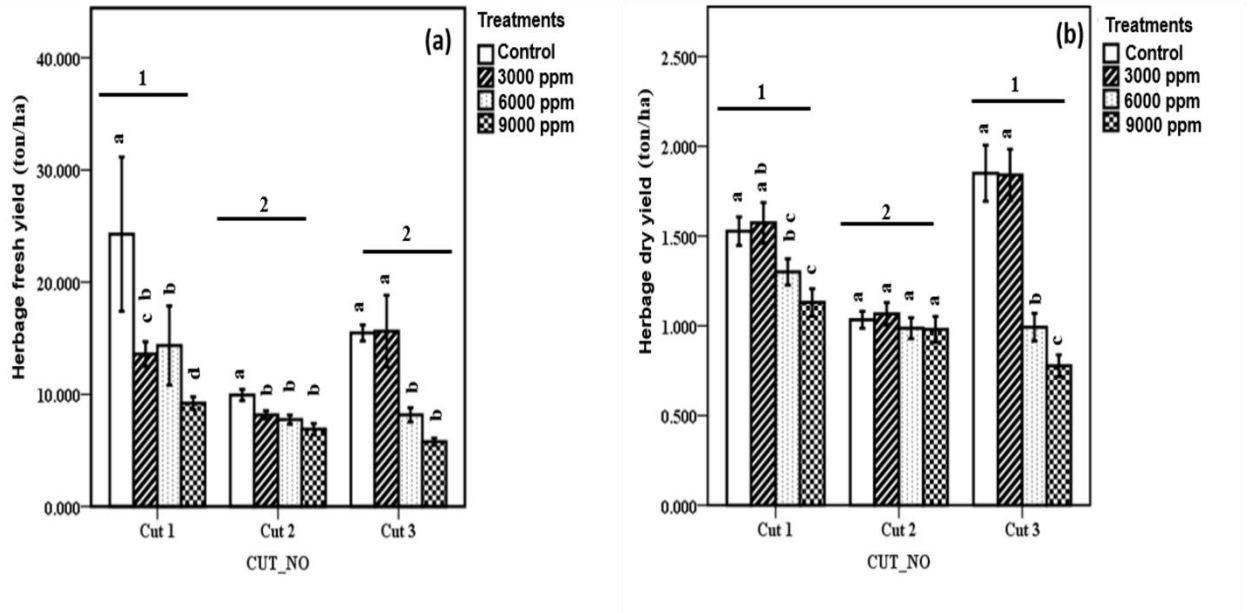

Figure 2 (a) Herbage fresh yield and (b) Herbage dry yield of kale cultivated under fresh water (control) and different salinities (3000 ppm, 6000 ppm, and 9000 ppm) at different cutting time points. Data expressed as mean ± SE. Error bars represent the standard error. Bar columns within the same cutting time point having different letters are significantly different (P < 0.05). Horizontal bars at the top of bar columns having different numbers indicate a significant difference between cutting time points (P < 0.05).

Likewise, rearing *Oreochromis niloticus* at high water salinities did not negatively impact the water quality and the growth performance, survival, and feed utilization of fish. Overall, cultivating kale and rearing *O. niloticus* in IAVS in water salinities reaching up to 6000 ppm

could be a sustainable agricultural strategy to increase food production in regions affected by freshwater scarcity.

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Biofloc Systems for Sustainable Production of Economically Important Aquatic Species

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Keywords: aquaculture, biofloc technology, integrated multi-trophic aquaculture, sustainability.
CWW2023 Theme: 1

ABSTRACT

The increasing global population has led to an increase in food demand; consequently, aquaculture is one of the food production sectors that has offered opportunities to alleviate hunger, malnutrition, and poverty [1]. However, the development of a sustainable aquaculture industry has been hindered by the limited availability of natural resources as well as its negative impact on the surrounding environment [2]. Hence, there is an urgent need to search for better aquacultural production systems that, despite their high productivity and profitability, utilize fewer resources such as water, energy, land, and capital in conjunction with a negligible impact on the environment. Biofloc technology (BFT) is one of the most exciting and promising sustainable aquaculture systems; it takes into account the intensive culture of aquatic species, zero water exchange, and improved water quality as a result of beneficial microbial biomass activity, which, at the same time, can be utilized as a nutritious aquaculture feed, thus lowering the costs of production [3,4].

A detailed literature search was conducted via Google scholar, Web of Science, and Science Direct to extract information from published journal articles on biofloc technology following the preferred reporting items for systematic reviews and meta-analysis. Articles were screened through reading their titles and abstracts, duplicates removed and relevant studies to our topic were selected based on our inclusion criteria (i.e. experiments done on biofloc technology; experiments on the integration of biofloc technology with agriculture; and studies on co-cultivation of different aquaculture species under biofloc conditions).

Several studies indicated efficiency of biofloc technology systems in water purification through microbial activity (**Figure 1**) hence limiting water renewal and facilitating improved fish performance in terms of body weight gain, feed conversion ratio, specific growth rate and survival. Moreover, reduced feeding costs were reported due to the utilization of flocs as an alternative feed by the reared aquatic species. It was also found that the system can permit co-cultivation of different species (multi-trophic aquaculture) where the wastes of one organism could be utilized as a nutrient source for another organism. Likewise, halophytes such as *Ulva fasciata* and *Sarcocornia ambigua* could be used for the absorption

of nitrogen and phosphorus, all of which lead to the maintenance of good water quality and the improved survival and growth performance of the reared species.

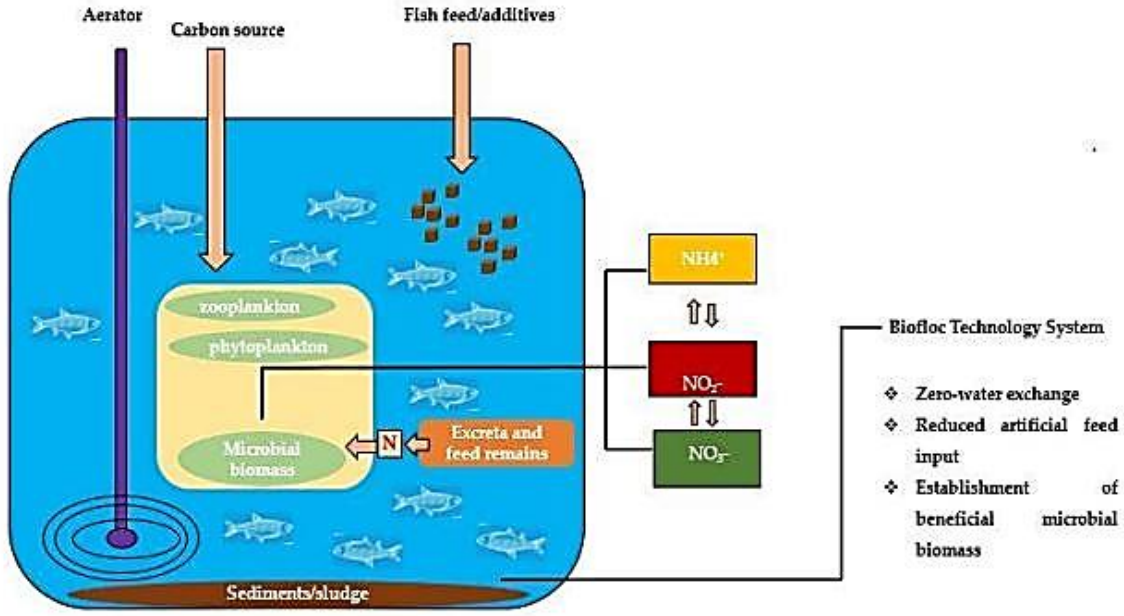

Figure 1. Schematic diagram of a biofloc technology system

In conclusion therefore, this review, highlights the basics of BFT, factors associated with BFT for the successful production of aquatic species, the significance of this food production system for the sustainable production of economically important aquatic species.

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Retention dikes in the Caplina basin, headwaters of the Atacama Desert, as protection and recharge of the Caplina aquifer against the effects of climate change

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Keywords: Atacama Desert; climate change; debris flow; dike dimensions; underground recharge.
CWW2023 Theme: 1

ABSTRACT

Global climate change suggests negative changes in the hydrological systems, with significant changes in precipitation and temperature in many parts of the world. Thus, floods and droughts are expected. This article analyzes the potential effects of climate change and variability in maximum precipitation, temperature, and hydrological regime in the Caplina basin, Tacna, Peru.

The Atacama Desert is located in the north of Chile and south of Peru, in South America. This continent is characterized by various atmospheric phenomena and climatic regimes, from very arid to very humid [1,2]. The city of Tacna, where the Devil's Ravine is located, is in one of the main deserts in the world [2]; it has a hyperarid climate and is attributed to its subtropical location [3]. The study area is located on the northern edge of the hyperarid core of the Atacama Desert. In this ecosystem, there have been arid periods and significant changes in its hydrological regime towards extreme events that generate debris flows [4].

The Peruvian territory, due to its geographical location, is one of the most unstable areas of the continent, whose geological, geomorphological, climatological, and seismic characteristics facilitate the development of Mass Movements Likewise, the vulnerability process is manifested by a marginal urban demographic growth, accelerated and chaotic. In the present investigation the hydraulic modeling will be developed to determine the dimensioning of the sediment retention dam. In hydrology, the tools of geographic information systems facilitate the acquisition of LANDSAT 8 images in 2020 using the Google Earth Engine software [5,6]. Exploratory work in the field and documented analysis were carried out to establish the type of debris flow retention structure and its dimensions.

The hydraulic modeling results indicate that the simulated event in the "unclogged" condition of the channel (that is, without the Camiara pass) does not generate more significant flooding of the streets, as observed in Figure 1 left. The maximum depth within the ravine (range of the canyon, upstream from the urban area) is approximately 0.20 – 0.50 m, except in some points where it can reach 1 m. When the hydrograph upstream of the dam break is directed through the creek and towards the city of Tacna, a large area is flooded at very high velocities. Figure 1 right, shows the flow depths in detail. In the hydraulic simulation, near the mouth of the creek, where a human settlement interrupts its course, flow depths between 2.8 and 4.9 m are reached. This depth is sufficient to cover one or two floors

of a residential building. In addition, the simulated flow velocities near the mouth of the stream are 5 to 15 m/s and can even reach 35 m/s in one of the streets (shown in red dotted line).

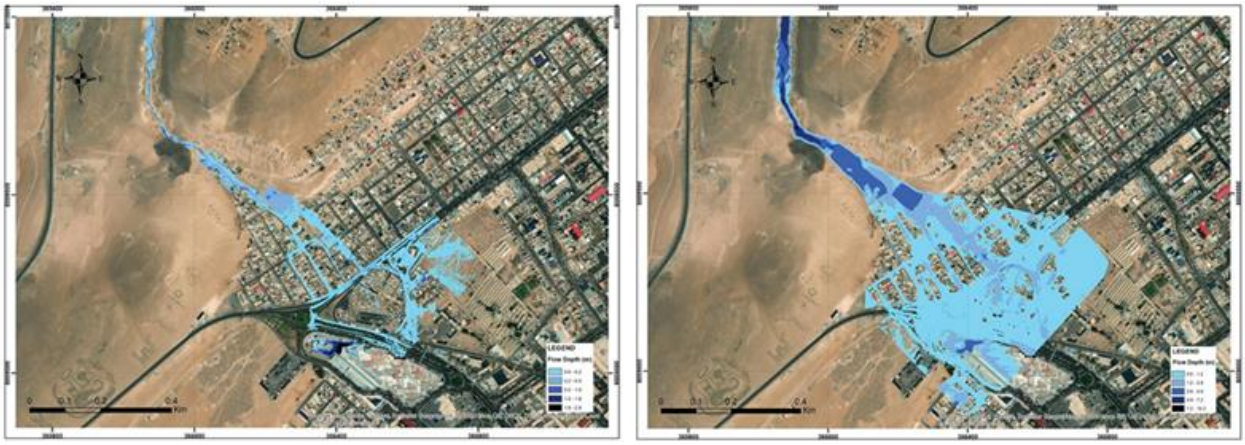

Figure 1. Flow depth output overlaid with a satellite image of the affected area for the no embankment condition (left). Maximum Flow Depths of the February 21, 2020 Event Reenactment (right)

The work components of a landslide control scheme in the Devil's Creek basin are: (a) Landslide retention dam, made of massive concrete, stone masonry, earth, and rockfill. (b) Spillway for the discharge of surplus water flows, conventional spillway type, stepped spillway, mixed spillway. (c) Collection of debris flows in the reservoir for its transfer from the basin. (d) Bottom discharge of the debris flow, if technically warranted. The selection of the position and height of the reservoir during the design process of the debris flow retention dam is a complex task. The calculation usually begins with the designation of some variants of the depth of the reservoir for each elevation of the retention for which flow regulation is carried out during the period of hydrological observations.

Considering the physical, geological, morphological, and other conditions of the basins of the ravines involved and associated with mudslide events, in the basin of the Devil's Creek stream, two places for the emplacement of mudslide retention dams are proposed (Figure 2).

As a mitigation measure for the destructive effect of these extreme hydrological events, two debris flow retention structures or dikes are proposed, with fundamental characteristics defined as follows: PRH-D1: Earth dam and rockfill for the retention of mudslides, with 24.00 m height. Within the scheme of works, a catchment and spillway for excess flows of huaicos is planned, followed by an open conduction channel towards the neighboring basin located on the right bank. The PRH-D2: Concrete-gravity or cyclopean concrete dam for the retention of mudslides in the Quebrada del Diablo, 25.00 m high. Within the scheme of works, a catchment and spillway for excess flows of huaicos are planned, followed by an open conduction channel towards the neighboring basin located on the right bank. The freshwater produced in rainy seasons will be induced to increase underground water resources.

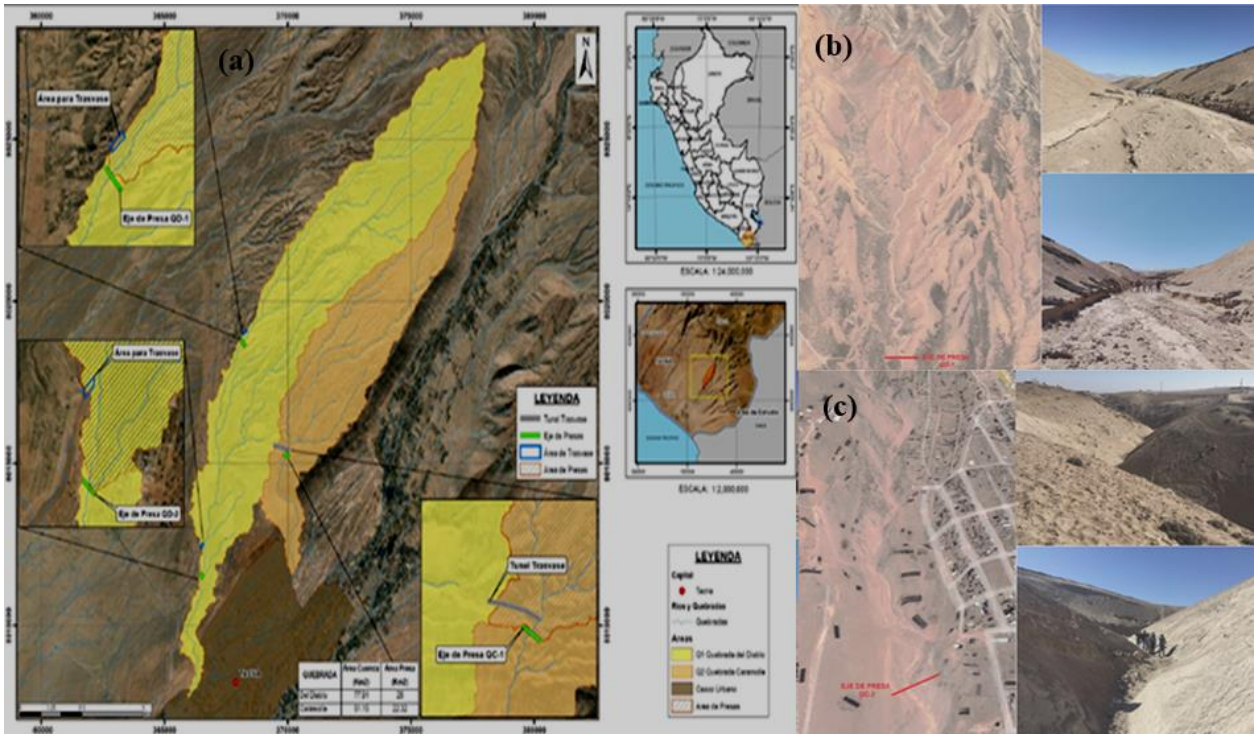

Figure 2. (a) Approach to alternative structural measures for the comprehensive control of landslides affecting Tacna. (b) View of the axis of the QD-1 (left). (c) QD-2 (right) dam for landslide control and the solids storage vessel.

Acknowledgment

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Impacts of Climate Change on Egypt's Green Economy: Sustainable Practices in the Nile Delta

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Keywords: Climate-Resilient Planning, Drip Irrigation, Precision Farming, Sustainable Practices
CWW2023 Theme: **1**

ABSTRACT

This study aims to compare and evaluate the performance of three farming practices mainly Precision Farming, Drip Irrigation, and Climate-Resilient Planning in the context of the Nile Delta region. The assessment is conducted using a multi-dimensional analysis, considering indicators related to environmental impact, social impact, economic impact, and policy implications. Indicators such as water conservation, soil health improvement, climate resilience, biodiversity preservation, social engagement, economic benefits, and policy support were considered. A scoring system ranging from 1 to 3 was used, with 3 indicating the highest performance. Data from literature, farming practices, and empirical sources specific to the Nile Delta were collected. Scores were assigned to each farming practices for each indicator. Total scores were calculated to provide an overall assessment. Results show that Climate-Resilient Planning received the highest total score, indicating its effectiveness across multiple dimensions. Drip Irrigation also performed well, particularly in water conservation and social and economic impacts. Precision Farming excelled in environmental impact and economic benefits. The findings inform decision-makers, policymakers, and farmers about sustainable farming practices in the Nile Delta. The methodology used can guide future assessments in similar agricultural contexts. Further research is recommended for validation and expansion of these findings.

Introduction

Climate change presents significant challenges to Egypt's green economy, particularly in regions like the Nile Delta. The Nile Delta is highly vulnerable to the impacts of global warming and sea-level rise, making it imperative to understand the comprehensive implications of climate change on Egypt's green economy, especially in this region. The Nile Delta plays a critical role in Egypt's agricultural sector due to its fertile soils and extensive agricultural activities. However, the region faces numerous climate-related challenges that pose a threat to its productivity and sustainability. Increased temperatures lead to heat stress, affecting crop yields and livestock production (Sallam et al., 2020). Erratic rainfall patterns disrupt traditional farming practices, causing water scarcity issues and affecting the availability of irrigation (El-Kenawy et al., 2018). Furthermore, rising sea levels exacerbate the risk of saltwater intrusion into agricultural lands, rendering them less suitable for cultivation (El Raey, 2019). These climate-related challenges have direct implications for

the agricultural sector, which is a key component of Egypt's green economy. Agriculture contributes significantly to the country's GDP and employment, making it vital for food security and economic stability (World Bank., 2023). Adapting to climate change impacts and implementing sustainable practices in the agricultural sector are essential to ensure the resilience and long-term viability of Egypt's green economy in the Nile Delta region. Precision farming, drip irrigation, and climate-resilient planning are three case studies for farming practices that hold promise in addressing the challenges posed by climate change and promoting sustainable agricultural practices in the Nile Delta. This comparative analysis aims to assess the environmental, social, economic, and policy impacts of these approaches, based on the evaluation of specific criteria.

Methodology

The research methodology employed in this study utilized a deductive and scoring approach, which was implemented through multiple stages as outlined as identifying a set of indicators, establish a scoring system for each indicator to assess the performance of the 3 case studies of farming practices, collecting relevant data and information to evaluate the performance of each farming practices for each indicator, assign scores to each farming practices for each indicator according to their observed or reported performance and calculating the total score for each case by summing up the scores across all indicators. A scoring system of 1 to 3 has been used, with 3 indicating the highest performance and 1 indicating the lowest performance. The scores assigned to each farming practices for each indicator are based on this scoring system.

Results and Discussion

Environmental Impact: In terms of water conservation, drip irrigation emerges as the most effective approach with a score of 3, indicating a high level of water-saving potential. Precision farming receives a score of 2, while climate-resilient planning scores 1, suggesting relatively lower emphasis on water conservation. However, climate-resilient planning stands out in terms of climate resilience and biodiversity preservation, both scoring 3, while precision farming and drip irrigation score 2 and 2 respectively. All three farming practices receive the same score of 9 for Environmental Impact, indicating that they have similar overall performance in this area (Table 1).

Social Impact: Community engagement plays a crucial role in promoting sustainable agricultural practices. Drip irrigation and climate-resilient planning both score 3, reflecting their high potential for community engagement, while precision farming receives a score of 2. Capacity building, health benefits, and social equity also receive higher scores for drip irrigation and climate-resilient planning compared to precision farming. Drip Irrigation receives the highest score of 10 for Social Impact, suggesting its effectiveness in this area (Table 1).

Economic Impact: Precision farming is identified as the approach with the highest potential for job creation, scoring 3, while drip irrigation and climate-resilient planning score 2. Drip irrigation is noted for its market opportunities and cost savings potential, receiving scores of 3 and 3, respectively. Precision farming scores 2 in both categories. However, Drip Irrigation receives the highest score of 8 for Economic Impact (Table 1).

Policy Implications: All three approaches demonstrate a considerable level of policy support, with drip irrigation and climate-resilient planning scoring 3 and precision farming scoring 2. In terms of regulatory framework and financial incentives, climate-resilient planning

receives the highest score of 3, while drip irrigation scores 2 and precision farming scores 1. However, the overall Climate-Resilient Planning receives the highest score of 8 for Policy Implications (Table 1).

The overall Assessment: Based on the evaluation of the criteria, climate-resilient planning emerges as the approach with the highest total score of 35, indicating its potential to have comprehensive impacts across environmental, social, economic, and policy dimensions. It demonstrates strengths in water conservation, climate resilience, biodiversity preservation, community engagement, capacity building, social equity, policy support, regulatory framework, and financial incentives. Drip irrigation follows with a total score of 34, showcasing its effectiveness in water conservation, market opportunities, cost savings, community engagement, health benefits, and policy support. Precision farming receives the lowest total score of 28, with notable strengths in job creation and moderate scores in water conservation, soil health improvement, market opportunities, and policy support (Table 1).

Table 1: Comparative Analysis for Farming Practices

Indicators / Case Study	**Precision Farming**	**Drip Irrigation**	**Climate-Resilient Planning**
Environmental Impact	**9**	**9**	**9**
Water Conservation	2	3	1
Soil Health Improvement	2	1	2
Climate Resilience	3	3	3
Biodiversity Preservation	2	2	3
Social Impact	**8**	**10**	**11**
Community Engagement	2	3	3
Capacity Building	3	2	3
Health Benefits	2	3	2
Social Equity	1	2	3
Economic Impact	**7**	**8**	**6**
Job Creation	3	2	2
Market Opportunities	2	3	2
Cost Savings	2	3	2
Policy Implications	**4**	**7**	**8**
Policy Support	2	3	3
Regulatory Framework	1	2	3
Financial Incentives	1	2	3
Total Score	**28**	**34**	**35**

Conclusion

This comparative analysis highlights the strengths and weaknesses of farming practices (precision farming, drip irrigation, and climate-resilient planning) in terms of their environmental, social, economic, and policy impacts. While each approach has its merits, climate-resilient planning emerges as the most comprehensive solution, considering its focus on climate resilience, biodiversity preservation, community engagement, and policy support.

Drip Irrigation also scores well overall, with a strong focus on water conservation, social impact, and economic impact. Precision Farming performs well in environmental impact and economic impact, but has lower scores in social impact and policy implications. However, the selection of an appropriate approach should be context-specific, considering the unique requirements and challenges of each situation. Further research and interdisciplinary collaborations are needed to enhance the effectiveness and scalability of these approaches and maximize their contributions to sustainable agriculture and climate change adaptation.

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Theme 2: Cooperative Management of River Basins

Managing Toshka spillway in absence of coordination with GERD
Aref Gharib, Loay Seif, Mohamed Khaled

Monitoring and Tracking Aquatic Weeds in the White Nile: Identifying Sources and Developing Management Strategies
Sara Zouriq , Aref Gharib

Seasonal River Flow Forecasting over the Upper Blue Nile Basin
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Modelling the Wetlands of the Nile Basin
Hubert Lohr , Karim Soliman, Nada Abdelwahab, Felix Froehlich, Modathir Zaroug

Investigation of the Climatic Mechanisms that Complement El-Nino/La-Nina Events for Causing the Blue Nile Flood/Drought Periods
Nabil Anwar , Dina Ibrahim, Sohair Mansour

Water Diplomacy and Cooperation in Eastern Nile Basin
Ali Elhaj , Meseret Dawit, Eng.Robert Zakayo, Harb A. El-bardisy.

Managing Toshka Spillway in Absence of Coordination with GERD

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Keywords: HAD, Toshka, GERD, Agreement, lack of information.
CWW2023 Theme: 2

ABSTRACT

The inclusion of Toshka depression was not initially part of the original design of the High Aswan Dam (HAD). However, following the construction of HAD and the realization of its benefits, such as regulated water flow, certain unfavorable activities began to emerge that restricted the capacity of the Nile's watercourse downstream of HAD. In order to address this issue and avoid overloading the downstream area, an alternative path needed to be identified for use during consecutive years of flooding. Through comprehensive field investigations and survey efforts, the Toshka depression was identified as a viable alternative solution. The Toshka spillway functions as a crucial water management infrastructure in Egypt, specifically designed to discharge the surplus water from Lake Nasser to the Toshka Depressions. Its primary objective is to ensure the integrity and safety of the High Aswan Dam (HAD) while mitigating the risk of downstream damages during periods of high flood conditions.

The construction of the Grand Ethiopian Renaissance Dam (GERD) has raised apprehensions regarding the possible risks and challenges that may arise, particularly in the absence of a mutually agreed-upon agreement governs the filling and operation of GERD. These concerns mainly revolve around potential modifications in water quantity and distribution patterns, which could have a significant impact on the functioning of the HAD. To address these concerns, it is crucial to establish operational regulations and ensure transparent data sharing. While recent focus has been on managing drought periods, it is essential to update these strategies to include periods of increased water flow and how the GERD can collaborate to mitigate surges before they reach downstream dams, notably the HAD and its auxiliary structures, such as the Toshka spillway.

The recent floods on the Nile River, combined with the absence of coordination between the GERD and the HAD, as well as insufficient information about the GERD filling process, has led to a state of disarray in the management of water resources in Egypt. During the negotiations between the three countries (Egypt, Sudan, Ethiopia), Ethiopia presented a proposed filling table of GERD. Unfortunately, the numbers proposed by Ethiopia were altered during the negotiation process. For example, according to Tables No.1,2 submitted by the Ethiopia, during the first year GERD was supposed to store 4.9 BCM but actually this year GERD has filled only 3.6 BCM, the second filling phase has

divided into two parts phase 1&2, GERD was intended to store 13.5 BCM of water, such big quantity led Egypt to store more water in HAD as a precaution in case of droughts coinciding with the filling process. However, Ethiopia changed this number to 3.7 BCM only, and adjust the upper value of phase 3 to be 600m (Target elevation level at the end of hydrological year) instead of 595m, causing significant confusion in HAD and water resources management in Egypt as a result, water was releases into the Toshka spillway to ensure the safety of HAD. generally, Ethiopia has totally changed all value of filling stages in the two submitted Table 1,2.

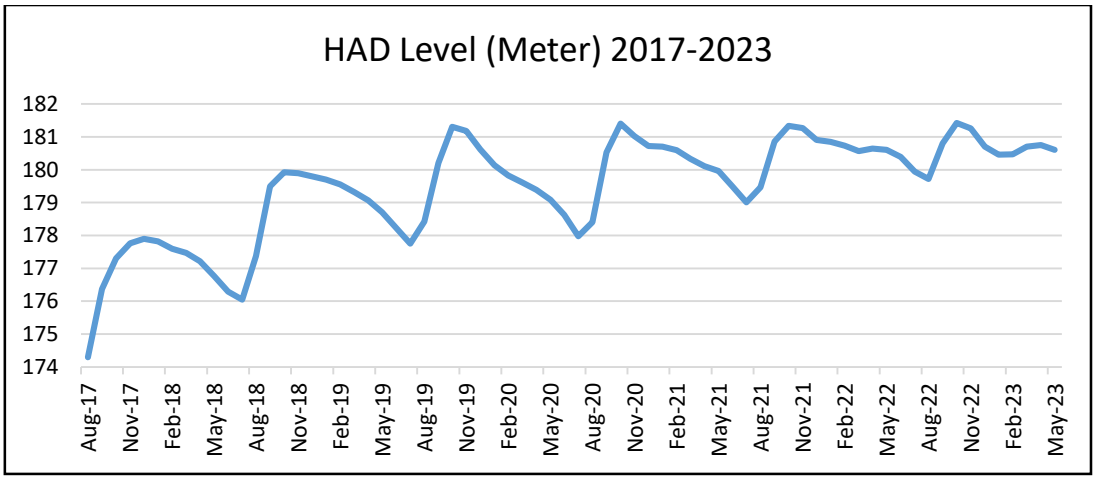
Table (1): The proposed Ethiopian GERD Filling Process

Stage	Target elevation level at end of hydrological year	Max. incremental retained water (BCM) at end of hydrological year	Max cumulative retained water (BCM) at end of hydrological year
Phase (1)	565	4.9	4.9
	595	13.5	18.4
2	608	10.5	28.9
3	617	10.4	39.3
4	625	10	49.4

Table (2): The proposed Ethiopian GERD Filling Process

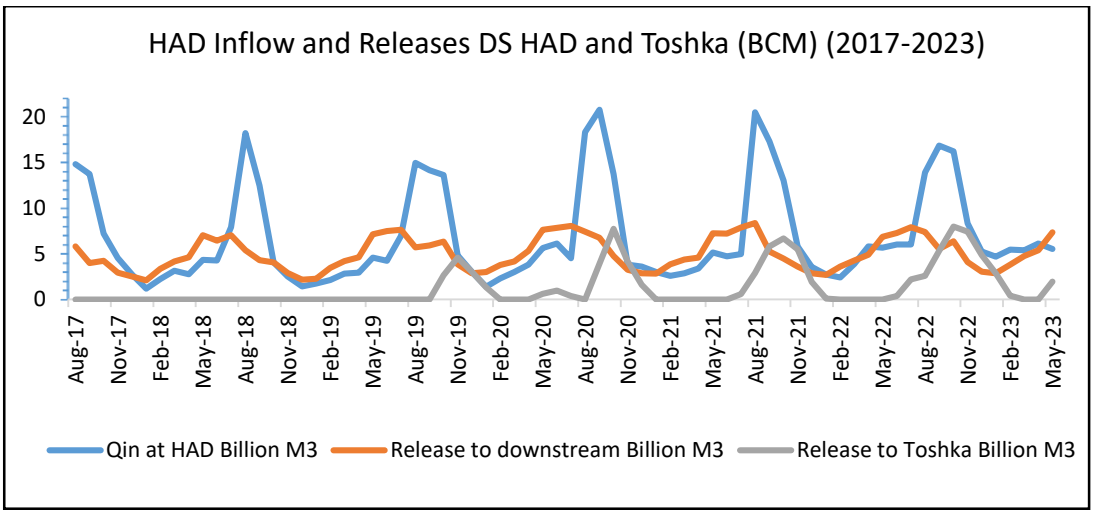
Stage	Target elevation level at end of hydrological year	Max. incremental retained water (BCM) at end of hydrological year	Max cumulative retained water (BCM) at end of hydrological year
1-Phase (1)	565	4.9	4.9
1-Phase (2)	576	3.7	8.6
1-Phase (3)	600	13.6	22.2
2	612	10.8	33
3	620	10	43
4	625	6.3	49.3

The Graph (1) the increase of water level at HAD which has been recorded over the past five years, from 2017 to 2023 provides valuable data for understanding trends and how the high floods of Nile river and the non-coordination policy effect on the HAD water levels and the potential risks that could pose to the dam safety.



Graph (1): HAD levels in the past five years, from 2017 to 2023

Egypt and Sudan have implemented high-cost measures to reduce the risk associated with the GERD filling process. Egypt planned to keep an additional reserve storage at HAD, as well as reducing the area of land used to grow water-intensive crops such as rice to minimize water release downstream. This would conserve water resources to overcome the GERD scheduled filling plan, but with a corresponding significant economic and social implications. Also would require significant investment in infrastructure, technology, and training for farmers. Therefore, careful planning and stakeholder engagement would be essential to ensure the success of any changes in crop pattern. Graph (2) displays the flow at HAD and the release to downstream and Toshka from 2017 to 2023, showing Egypt's management of the GERD filling process without coordination mechanism between the three countries.



Graph (2): HAD Inflow and Releases DS HAD and Toshka (2017-2023)

Conclusions

Toshka Spillway plays a crucial role in managing the water resources in Egypt during flood seasons and even during the filling and operation of the GERD, mainly due to the non-existence fair and balanced Agreement which should contains a robust data exchange mechanism.

Overall, the Toshka Spillway presents a vital part of Egypt's water management system and support sustainable development. It is a model of how engineering and technology can be used to address water scarcity and support economic growth, while also protecting communities and environment not at flood periods only but also on the case of no active regional cooperation and coordination.

An agreement regarding the filling and operation of the Grand Ethiopian Renaissance Dam (GERD) is crucial for various reasons. Firstly, it plays a significant role in promoting regional stability, as it helps avoid conflicts between Ethiopia and downstream countries. Secondly, it ensures water security for countries like Sudan and Egypt, who rely heavily on the Nile River. Thirdly, it fosters cooperation between the countries, which can lead to several economic and social benefits. Fourthly, it provides clarity for investors by offering a predictable framework for the project's development. Additionally, such an agreement can also facilitate the downstream countries in operating their dams efficiently and effectively.

Acknowledgment: Nile Control Central Department (Nile Water Sector, MWRI, Egypt)

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Monitoring and Tracking Aquatic Weeds in the White Nile: Identifying Sources and Developing Management Strategies"

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Keywords: Aquatic weeds, GIS, Remote sensing, Water resources management, White Nile, WEFE nexus.
CWW2023 Theme: 2

ABSTRACT

The White Nile grapples with a mounting challenge posed by aquatic weeds, presenting formidable obstacles to water resource management, navigation, water supply, and irrigation. This issue has reached critical proportions in recent years, with downstream channels and dams significantly affected. Urgent action is imperative, necessitating a comprehensive approach to tracking the issue's origins and devising effective management strategies.

Leveraging remote sensing and GIS technologies, our study scrutinized aquatic floating weeds along the White Nile from 2010 to 2023, facilitating real-time analysis of weed population fluctuations on a monthly basis. The study confirms that remote sensing technology stands as a cost-effective and efficient tool for the detection and monitoring of aquatic weeds, exemplified by our research. Furthermore, we expanded our research scope to encompass the primary sources of these weeds, which include the Sobat, Bahr El Jebel, Bahr Elzaraf, and Bahr El Ghazal rivers, with the aim of collaboratively formulating effective management strategies in conjunction with Egypt. Our monthly analyses are rigorously cross-referenced with ground truth data to ensure precision.

In addition to our findings on weed invasion percentages ranging from 30% to 70%, our research offers invaluable insights into the complex interplay between water, food, and energy (WEFE) systems. By harnessing remote sensing technology, we empower informed decision-making and optimize resource allocation, facilitating the efficient management of the aquatic weed conundrum. We also spotlight the potential of utilizing aquatic weeds as a sustainable resource for biogas production to support the energy sector. Moreover, the compost derived from these weeds can be a boon to agriculture, resulting in significant environmental benefits.

Problem Statement

Water, a crucial natural resource and the foundation of all life forms [1], is facing increasing challenges from aquatic weeds. These prolific plants, growing abundantly in undesired aquatic environments [2], have become a global problem influenced by factors such as industrialization, travel advancements, agricultural productivity, population growth, and changes in consumption patterns. The excessive presence of aquatic vegetation significantly impacts water management worldwide, posing severe challenges for agriculture, aquaculture, natural areas, human populations, and economic stability [3]. Sudan's White Nile has experienced a significant increase in water flow in recent years, surpassing the historic flood of 1965 by approximately 25%. Rising lake levels at the headwaters of the White Nile have

led to increased revenue during 2021-2022 (as shown in Figure 1). Complaints in November 2022 from citizens in the south of Kosti reported noticeable increases in water levels. Despite efforts to reduce lake levels, the Ministry of Irrigation was unsuccessful in lowering the water level in affected areas. In the Duweim area, citizens complained about drought and the inability of pumps to withdraw water due to receding levels (Ministry of Irrigation and Water Resources in Sudan).

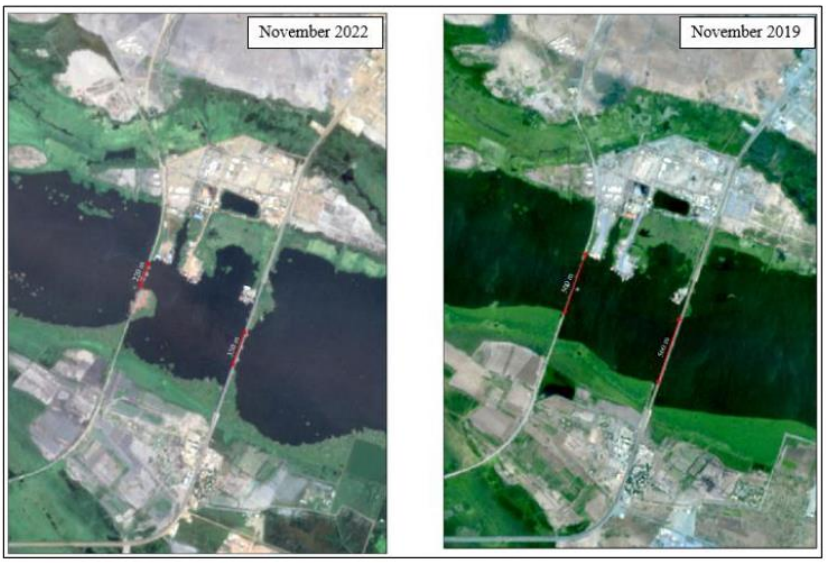

Figure 1. The narrowness of the stream as a result of the accumulation of floating weeds at the bridges of the city of Kosti

Methodology

This research paper focuses on satellite image processing to compute vegetation indices (VIs) using multispectral bands. The objective is to analyze vegetation indices derived from satellite data collected from Kosti to upstream rivers, investigating the underlying causes of observed floating aquatic weeds. The study highlights the limitations of conventional Geographic Information System (GIS) methods [4-8] commonly used for such tasks.

To further investigate the root cause of the problem, a dive into the upstream rivers, including Sobat, Bahr Elgabal, Bahr El Zaraf, and Bahr El Ghazal, was conducted. A time series visual interpretation and the use of the NDVI (Normalized Difference Vegetation Index) were employed during this analysis. The findings revealed that there has been an increase in the amount of aquatic weeds in these streams over the past three years, with Bahr El Ghazal contributing the most to this issue.

In response to the request from Sudan and South Sudan, Egypt has acted to address the problem in Bahr El Ghazal, located in South Sudan. As a means of cooperation with the Nile Basin countries, Egypt has initiated mechanical removal of these aquatic weeds. This collaborative effort aims to mitigate the proliferation of weeds and combat their adverse effects on the water bodies, thereby addressing the issue at its source

Satellite image processing, combined with ground truthing and collaboration with the Ministry of Water Resources and Irrigation in Sudan, validated the findings and confirmed the accuracy of the assessments related to the aquatic weed issue in Kosti.

Results and Discussion

This study utilized advanced satellite technology, including ESA's Sentinel-1 and Sentinel-2, and Landsat, to monitor water hyacinth in the White Nile. Optical and radar data helped distinguish hyacinth from other aquatic features, and the Sentinel-2's high-resolution imaging enhanced our ability to detect and estimate hyacinth infestation.

Our findings revealed significant river narrowing near the Kosti bridges, reaching 75% and 66%. River blockage varied, with a 70% increase in Sudan and percentages of 30% to 50% in South Sudan (White Nile), 40% to 60% (Sobat River), 10% to 25% (Bahr El Zaraf River), and 40% (Bahr El Ghazal River). These percentages are relative and based on comparisons between 2017 and 2023 conditions.

Additionally, the White Nile saw a 25% increase in water flow, surpassing the 1965 flood due to rising lake levels. Residents in the south of Kosti reported elevated water levels in November 2022.

In summary, our study highlights increasing water levels, floods, and hyacinth invasion in the White Nile, affecting Sudan and South Sudan.

Conclusion and Way Forward

Aquatic weeds represent a complex challenge intertwined with valuable opportunities. These plants can be harnessed for biogas production, providing a sustainable energy source for crucial activities such as water pumping. Simultaneously, the resulting weed-based compost emerges as a potent fertilizer for enhancing agricultural productivity. An integrated approach that considers the intricate water-energy-agriculture nexus not only transforms weed challenges into pathways for sustainable development but also optimizes resource utilization.

In the context of the water-energy-food-environment (WEFE) nexus, specific technical considerations come to the forefront. Determining the appropriate scale for the digestion system becomes pivotal, with each cubic meter of the plant-manure mixture yielding 0.2 to 0.6 cubic meters of gas daily. This gas proves versatile, catering to various energy needs, from cooking and lighting to machinery operation. Understanding household gas requirements, encompassing factors like gas burner consumption, torch usage, refrigerator efficiency, and internal combustion engine operation, becomes imperative. Remarkably, the operation of the biogas unit demands minimal labor, with a four-person team adequately handling both setup and day-to-day operation.

In conclusion, it is imperative that we take proactive measures to eradicate these invasive aquatic weeds, not only for our own benefit but also to support our neighboring countries in addressing this persistent challenge. Sustained monitoring, facilitated by cost-effective satellite-based tools, remains central to our collective efforts in combatting this issue, ultimately safeguarding the health and sustainability of our shared water resources.

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Seasonal River Flow Forecasting over the Upper Blue Nile

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Keywords: Blue Nile basin, CCSM4, ECMWF, flow forecast, GCMs, seasonal.
CWW2023 Theme: 2

ABSTRACT

The flow forecast information, for the river basin, can greatly aid the decision-making process for water resources management in Egypt. Where the limited hydrological data availability as well as the upstream basin developments, raises the importance of this forecast information. The principle of the seasonal forecast is to predict a range of most likely occurred values during the next season extending, probably, up to a year ahead. This research produces a comparison between two different seasonal flow forecasts over the Upper Blue Nile Basin (UBNB) using the seasonal rainfall forecasts produced by Global Circulation Models (GCMs) to investigate the suitable product that expresses the expected state of rain and flows of the Blue Nile River.

Despite a number of meteorological centers around the world make seasonal climate forecasts, the seasonal flows forecasts are still not as widespread and are in continuous development. Hydrological forecasts of water flows from supply catchments in major river basins on multi-week, seasonal and annual time scales are important to support water planning and management [1]. The two main sources of the seasonal hydrological forecasts are: 1) the information on the initial hydrological conditions (IHC) of the basin at the onset of a forecast and, which influence future flow, 2) reliable information about future climate variability (FCV), represented by the development of precipitation, temperature and other atmospheric variables during the forecast period [2,3]. The impact of the IHC is significant in situations of the large and perennial river systems, while the spread of future climate drivers is relatively small. Dynamical modelling, which couples climate and hydrological models, provides relatively narrow ensembles when compared to the classical Ensemble Streamflow Prediction (ESP) method [4], which uses historical climatology as meteorological ensemble input. ESP method has been widely used around the world over the last 40 years [5], where it is already operated in Nile Forecasting Center in Egypt [6]. The importance of IHCs decreased in case of a strong climate driver dominates the predictability. where the impact of IHCs might be expected to be smaller compared to FCV during the significant El Niño and La Niña years than during neutral years [3] for a location where hydrological variables are highly correlated with El Niño-Southern Oscillation (ENSO), where catchments are associated with highly unpredictable and non-linear response to rainfall events.

In this research, two different products of daily seasonal rainfall forecast with multi-ensembles were used. One of them is a processed product produced in the SaWaM project, which is based on the latest seasonal forecast product SEAS5 from the European

Centre for Medium-Range Weather Forecast (BCSD-SEAS5) with 25 ensembles. The other is the Community Climate System Model version 4 (CCSM4) with 10 ensembles. The two forecasts were bias-corrected using the linear correction method. The bias-corrected ensembles of the two forecasted products during the period (2000-2015) were fed the Surface Controlled Hydrologic (SCHydro) model, which was constructed in 2019 over the UBNB [7]. The results of the forecasted flow ensembles were analyzed and assessed against the observed flow data using three statistical criteria; Nash-Sutcliffe Efficiency (NSE), Percent Bias (Bias %) and Root Mean Squared Error to observation Standard Deviation Ratio (RSR) for the comparison.

Figure 1 shows a decadal boxplot of the forecasted flow mean ensemble up to Six-Months Lead-Time (LT6) (May - October) within the period (2000-2015) compared to the mean of the observed flow. It is noticed that the ensembles range is smaller in BCSD-SEAS5 than in CCSM4, which reduces the uncertainty range. In addition, at dry years, the boxplot mean of the BCSD-SEAS5 succeeds in capturing the mean of the observed flow. Generally, it is good to notice that the mean of 10 days observed flow lies within the interquartile range of the forecasted flow mean ensemble for all years for both models.

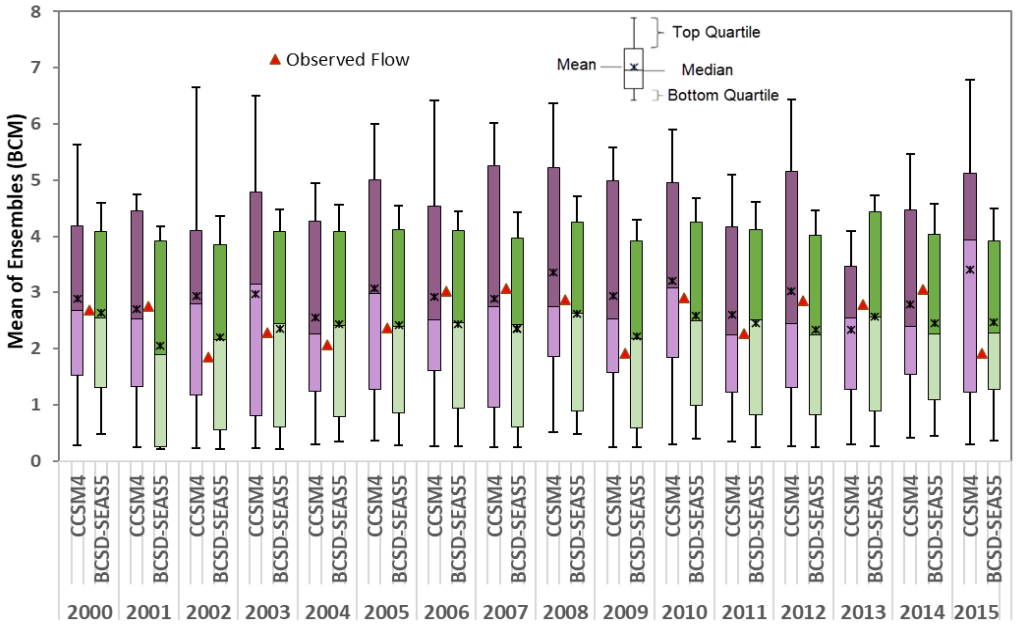
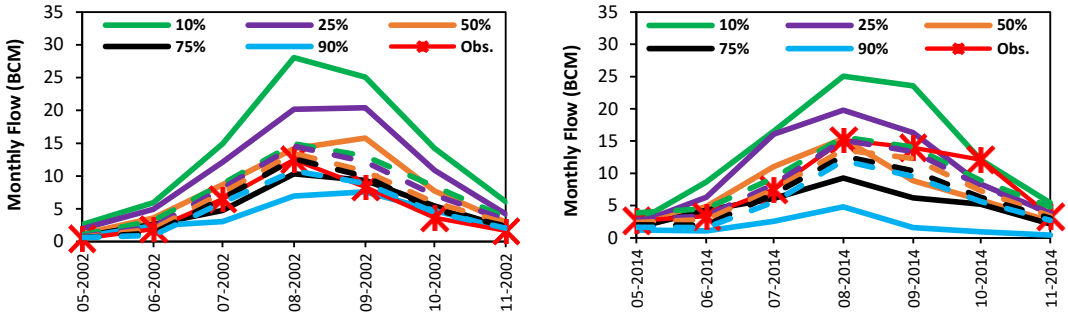


Figure 1. 10 days boxplot of the mean ensemble of forecasted flow and the mean of observed flow for the LT6 at Diem station

Figure 2 shows the 10%, 25%, 50%, 75%, and 90% probability of exceedance of the flow forecasted ensembles for the whole season (May - November) compared with the observed flow for the dry year (2002) and the wet year (2014). Firstly, it is noticed that the probability of exceedance range is closer to the observed flow in BCSD-SEAS5 than CCSM4, which confirms the outperformance of the BCSD-SEAS5. In addition, it is found that the forecast up to the first three months is very close to the 90% probability of exceedance, especially for the dry year (2002). This shows that the uncertainty increases with the long lead-time forecast. Therefore, the forecasting start must be updated every three months or every month to raise the forecast certainty. However, the

shown forecasted flow can give a good idea about the flood season when the forecasting starts at the beginning of the rainfall season.



Dry Year (2002) **Wet Year (2014)**

Figure 2. Probability of exceedance of the ensembles of the forecasted flow and the observed flow for the whole season at Diem station, straight lines present the performance of CCSM4, dotted lines present the BCSD-SEAS5

Table 1 shows the values of the statistical criteria; NSE, Bias% and RSR for LT6 forecasted flow. It is noted that the BCSD-SEAS5 has a very good performance rating for all the used statistical criteria, which is better than CCSM4 performance, especially for the NSE and RSR. This proves that the BCSD-SEAS5 succeeded in capturing the hydrograph peak and shape at the Diem station more than the CCSM4. However, both models can give a good idea about the flow over the UBNB up to the next six months.

Table1. The statistical criteria result for the forecasted flow

Statistical Criteria	CCSM4 (2000-2015)		BCSD-SEAS5 (2000-2015)	
	Value	Performance Rating	Value	Performance Rating
NSE	0.61	Satisfactory	0.77	Very Good
Bias (%)	14.60%	Good	-2.80%	Very Good
RSR	0.62	Satisfactory	0.48	Very Good

From the results, it is clear that the BBCD-SEASS rainfall forecast product is more sufficient to use for the flow forecasting over the UBNB; however, the comparison is applied on the whole rainy season for both of them give a good initial idea about the flood forecast at the beginning of the flood season. These forecasts could be enhanced if repeated again with a monthly time-step or at least repeated again before the flood peak. Finally, it is recommended to use the seasonal meteorological forecasts to forecast the flows until High Aswan Dam, and we encourage the Ministry of Water Resources and Irrigation to establish cooperation protocols with global forecast centers that have climate forecast models with high spatial and temporal accuracy to improve the performance of the NFC in Egypt.

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Modelling the Wetlands of the Nile Basin

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Keywords: Ecosystem service assessment, Inland Wetlands, Nested grid-based modelling, Talsim-NG model
CWW2023 Theme: 2

ABSTRACT

Modelling the large wetlands of the Nile Basin is of crucial importance to understand the hydrology of the Nile and to evaluate impacts on the wetlands resulting from changes in the hydrological regime. SYDRO Consult, with the financial fund of the German Agency for International Cooperation (GIZ) to support the Nile Basin Initiative, carried out a study on the Sudd, Machar Marshes, Bahr el Ghazal, Kagera, Semiliki Delta and Lake Kyoga wetlands' hydrology. The main objective was to assess the wetlands under the existing climate conditions, with the developed model also having the potential to evaluate the wetlands' performance under future climate change and infrastructure development scenarios. The primary assessment focused on ecosystem services such as fish, raw fuel production (papyrus), livestock, climate regulation (carbon dioxide emission), and water purification. Furthermore, additional assessments were carried out to estimate groundwater recharge to the system and determine water losses in the system caused by the wetlands.

The modelling was conducted using the software Talsim-NG, a fully-fledged river basin model that incorporates specific eco-hydrological features, enabling the modelling of wetlands with a complex atmosphere – vegetation – soil interface. Wetlands can be configured as gridded or watershed-based systems at a high spatial resolution and can be embedded as a nested model within a coarser-scale model, for example representing the entire Nile Basin providing the advantage of integrating rainfall-runoff processes, water infrastructure management and wetlands in one framework. The software has the capacity to perform long-term, continuous, and dynamic simulation runs with a flexible time step ranging from 1 minute to 1 month. The tool calculates eco-hydrological processes in parallel rather than following a pre-determined order. The sub-units of the model are connected and interact with neighboring units with regards to surface and sub-surface flow components. Complex hydrological processes of soil moisture, inundation and interconnected sequences of vicinal areas are reproduced.

To setup the model, various gridded input data were obtained; Digital Elevation Model (DEM) of Shuttle Radar Topography Mission (SRTM) of grid size 30 from NASA m developed by [1] , soil texture data of (SoilGrids) of International Soil Reference and Information Centre (ISRIC) developed by [2], climate data such as precipitation from the Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) satellite rainfall

estimate dataset analyzed by [3], temperature from the WorldClim observation climate reanalysis dataset analyzed [4], as well as observed discharge data located at the outlet of the wetlands acquired from the Integrated Knowledge Portal (IKP) of the Nile Basin Initiative collected from Nile Basin Decision Support System (NB-DSS) [5]. The potential evapotranspiration was estimated using the Blaney Criddle method [6], which only requires the maximum and minimum temperatures and the latitude coordinates of the study area.

The model was calibrated by matching the mean monthly observed timeseries with the simulated data in the model, which was achieved by adjusting global parameters in the model such as infiltration rate, soil saturation, and interflow scaling factors, etc. Furthermore, the water balance of the system was checked to verify the reliability of the model. Figure 1 depicts the comparison between observed and simulated mean monthly flow discharges, showing the mean annual flow discharge values for the Machar Marshes Wetland. Additionally, Table 1 shows the annual mass balance of the system following the calibration process.

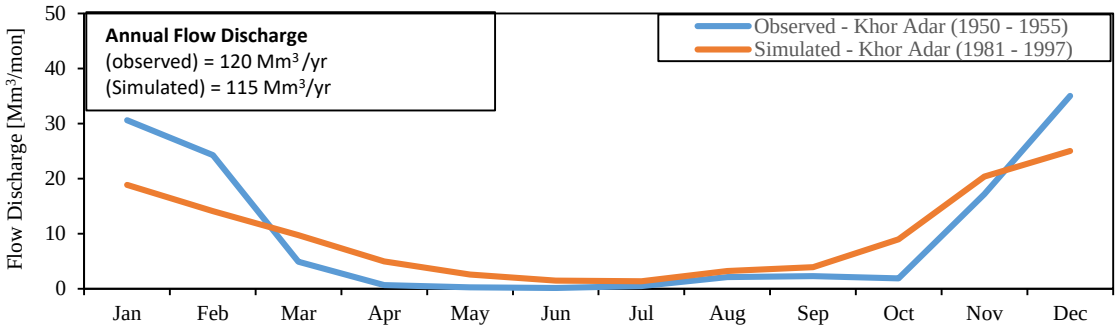

Figure 1. Comparison of the observed and simulated mean monthly discharge at Khor Adar – Machar Marshes.

Table 1. Annual mass balance of the Machar Marshes wetland.

Inflow [mm/yr]	Storage [mm/yr]	Outflow [mm/yr]	Error [%]
776.51	13.09	765.98	-0.33

After the calibration process, the model was validated by comparing the simulated results of the open water surface water extent with various monthly processed satellite data covering the period from 2000 to 2014. The satellite data processing involved the identification of open water and humid surface extent using remote sensing techniques. The satellite datasets were obtained from the Global Surface Water Explorer Dataset developed by the Joint Research Centre (JRC) of the European Commission [7] and the water bodies product was processed by Copernicus Global Land service [8]. The water depth factor of the model was adjusted to align with the satellite data measurements, enabling the distinction of open water status within the wetland, Figure2.

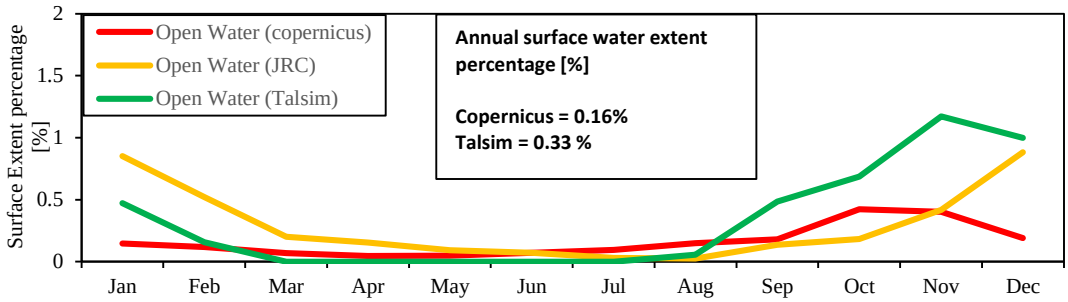

Figure 2. Comparison of the monthly wetland surface extent status (open water, humid vegetation) between TalsimNG and satellite processing images (Copernicus, JRC).

After incorporating various monthly processed satellite images depicting open water and humid vegetation, the wetland's state was identified and plotted taking into consideration spatial distribution and temporal variability based on water level and soil moisture content conditions. The wetland classification status are as follows: open water (when water level exceeds 0 m), wet (when water level is between -1 and 0 m), shortage (when water level is between -1 and -2), dry (when water level is below -2).

The results of the simulations of the nested finer spatial resolution modeling using raster grids demonstrate the successful calibration of the wetland models, which accurately capture real-world conditions. This validation was conducted by comparing the wetland states from the model with the processed satellite images showcasing surface water extent for open water and humid vegetation from 1981 till 2014. This approach could be further applied to assess the ecosystem services taking into consideration the time continuation of the open water and humid vegetation status, however real quantification of the ecosystem services has to be acquired for the different wetlands to ensure the reliability of the assessment.

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Investigation of the Climatic Mechanisms that Complement El-Nino/La-Nina Events for Causing the Blue Nile Flood/Drought Periods

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Keywords: Blue Nile, annual flood prediction, El-Niño/La-Niña, climate extreme events, floods/droughts.
CWW2023 Theme: 2

ABSTRACT

The Blue Nile Basin is known to encounter years with low/normal/high total flood volume. It is reported that the Blue Nile total annual flood volume is highly sensitive to changes in total annual rainfall depth [1]. This strongly affects the dependent countries in the basin, especially during prolonged flood/drought periods that may extend over several years. Preventive actions against high floods are very different from actions for low floods. Early prediction of the Blue Nile Annual flood is critically important to decide on the preventive measures before or at the beginning of the flood season.

El-Niño/normal/La-Niña alternating events induce significant impacts on floods/droughts in many locations in the world. Few works addressed the effect of these events on the Blue Nile annual flood variability (e.g. [2,3,4,5]). They found strong association, but not full agreement. Moreover, these works used only limited portions of the historical data records (e.g. [2] 1982 to 2018; [3] 1982 to 1989; [4] 1965 to 2012). Their results suggest that there are roles of other factors that complement these events to affect the Blue Nile annual floods/droughts.

When an El Niño event is followed by a La Niña event, there is a 67% chance for an extreme flood in the Blue Nile. Also, 83% of El Niño events starting in April–June resulted in droughts [3]. Model simulations [4] were made for the observed statistical relationship between ENSO and the rainfall regime of the upper Blue Nile using the tropical-band version of the regional climate model RegCM4 (or Reg-TB). They made an ensemble of nine simulations for the 28-years (1982-1989) over the Blue Nile. They reported good skill in simulating the rainy season climatology over the Blue Nile. They also reported success in reproducing the observed negative correlation between Pacific SST and rainfall anomalies and the association of the Blue Nile droughts with El Niño events that start in April–June.

The objective of this work is to investigate the mechanisms of climatic processes that accompany El-Niño and La-Niña events and complement their effects on the annual Blue Nile Basin floods/droughts. This is done by using published hindcast simulation results of the regional climate model RegCM4 [6]. These simulations are at 25kmX25km resolution, and use the General Circulation Model (MPI) simulation results for its input, which is run at 2.5°X2.5° resolutions. This models' set-up is also used for projections of future climatic changes until the year 2100. Examination of this set-up for hindcast simulations will assist in evaluating the future projection results. In addition, these simulations provide spatial and temporal of atmospheric components that are not measured, which can provide dynamic description for the climatic processes. This includes wind speed/direction, cloud intensity/directional movement, etc. Records of Blue Nile total annual flood volumes are used to evaluate the simulation results' reliability. Published rainfall dataset [7] is also used for the same purpose.

Recorded Blue Nile flood season total volumes at Khartoum for 1987 and 1998 were 32.2 and 61.0 BCM; respectively [1]. However, there were no significant differences between RegCM4 simulation results for the two years over the Blue Nile Basin (figure 2). Only, difference of about 15 cm was observed over equatorial Africa for both RegCM4 and CRU rainfall dataset. This is attributed to the GCM coarse resolution that cannot sense the long narrow strip of SST variation (figure 1). CRU dataset inadequacy maybe attributed to lack of data. The Blue Nile Basin terrain may require higher resolution simulations. Reg-TB [4] did not rely on GCM, and captured SST variations. It is recommended to add to MPI a high-resolution one-way nesting model for SST/land effects, and for RegCM4 to use dynamic downscaling for one-way nesting over the Blue Nile Basin using a meso-scale model to well-represent the terrain.

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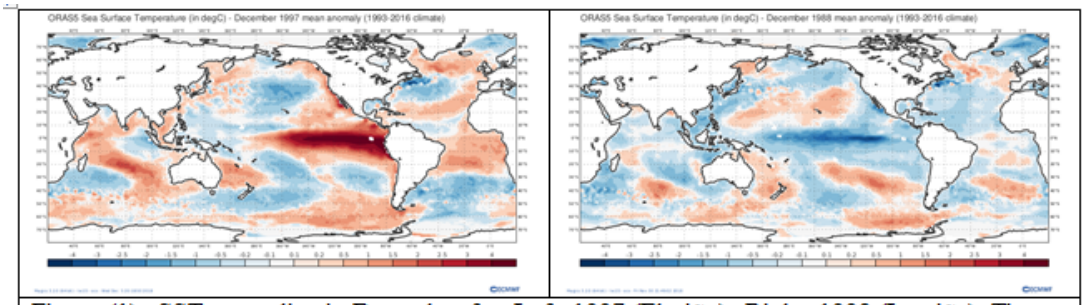

Figure (1). SST anomalies in December for: Left: 1997 (El-niño); Right: 1998 (La-niña). The two phenomena occur on a narrow long string in the equatorial Pacific Ocean, and the GCM coarse resolution of 2.5°X2.5° cannot read it properly, and hence cannot incorporate its effect in simulation results that are input to the regional model. Data Source: ECMWF;: https://charts.ecmwf.int/catalogue/packages/oras5/products/oras5_xymaps_1m?AnomalyMode=Full%20field&Field=Sea%20Surface%20Temperature&base_time=199712010000

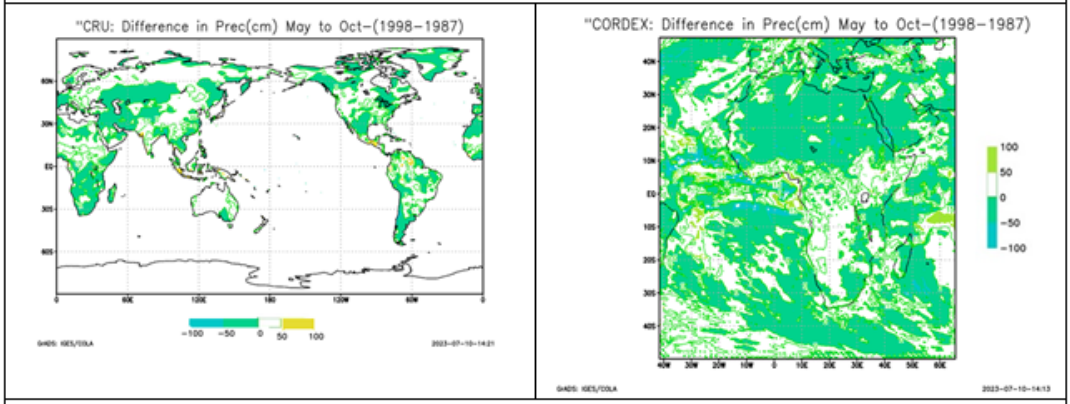

Figure (2). Difference in Total Precipitation (May to October) between 1998 (wet year) and 1987 (dry year). Left: CRU recompiled rainfall data. Units in cm, colorless area for 0 to 50 cm, contours of 15 cm were added. Other contours were of no significance. Difference below 0.0 cm negligible. Most difference on equatorial Africa around 15 cm. No significant differences on the blue Nile Basin. Right: CORDEX-RegCM4 hindcast regional model simulation outputs. Similar to comments for the figure in the Left side. Data Sources: https://cordex.org/domains/region-5-africa/ https://crudata.uea.ac.uk/cru/data/hrg/cru_ts_4.07/cruts.2304141047.v4.07/pre/ *Climatic Research Unit* : *Data* : *High-Resolution Datasets* : *CRU TS 4.07* : *CRU TS 4.07 Data Variables*

Water Diplomacy and Cooperation in Eastern Nile Basin.

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Keywords: Water Diplomacy, Eastern Nile Basin, Track II.
CWW2023 Theme: 2

ABSTRACT

Water is the resource that will determine the wealth, welfare, and stability of many countries in the twenty-first century. On the other hand, evaluated and reported the nexus of climate change, energy, and water security with con*flict* and development. The authors recommended that the integration of development with environmental factors and peacemaking has the potential to achieve sustainable development. Furthermore, the population growth in the Eastern Nile results in a rapid increase in demand for utilizing water, which is mainly taping to the Nile River. The countries are primarily focusing on satisfying the current needs and demand with less emphasis on the long-term effect effects such as climate change, inadequate water storage, and lack of coping with extreme events and related. On the other hand, Agriculture is the backbone for most of the Eastern Countries, and irrigated agriculture and energy are considered the primary driving force for enhancing food security and nutrition security [1,2]

To date, the hydro-politics of Nile water has entered a new phase in which the countries are having issues cooperating in the utilization and to benefit from the shared water resources. Consequently, the states are trying to use water diplomacy approaches that are not supplemented by international water laws to suit their interest. On the other hand, the history of the Nile and the complexity of the dispute, referring to the previous attempts for cooperation, it was evident that the EN Countries tend to pursue unilateral development of the Nile Water [3].

The paper aims to define the water diplomacy types, roles, and strategies in which to compare & contrast the experiences of water diplomacy approaches for transboundary water agreements, Treaties, and commissions, in the Nile Basin and specifically in Eastern Nile Basin. The comparison was to draw lessons that would contribute to the transformation of the conflict in the Eastern Nile Basin to achieve peaceful cooperation in sustainable management and development of the shared Nile Waters. The report assessed the role of multi-track water diplomacy in enhancing formal diplomacy, analyzed the past, and current water diplomacy approaches practiced by the Eastern Nile countries (Egypt, Ethiopia,

Sudan, and South Sudan), and identified the main challenges hindering the riparian countries to reach satisfactory dispute resolution acceptable to all riparian states [4].

This paper used multi-disciplinary approach, which is qualitative, and survey such as a) identifying the numerous water treaties and agreements that have signed as baseline; b) exploring the relevance and pitfalls of the previous agreements and cooperation; c) extracting lessons from the successful trans-boundary water treaties, which can be adapted for EN. Moreover, both the survey and the literature review were analyzed using a narrative approach, the analysis approach used is qualitative, with information extracted from the literature through observation and document analysis; however, a descriptive and explanatory method was used in the study to assess the existing and the potential and to draw results and recommendation.

The study indicated that water diplomacy approaches practiced in the Eastern Nile did not yield to cooperation, since it is not considering all the international rules and criteria for equitable utilization, benefit from the shared water resources, and fair allocation with no significant harm, on the other hand, not addressing the interest and the demand of the riparian state. The study indicated that the role of civil society and other actors in the region is significant in enhancing formal water diplomacy to reach an agreement. Moreover, the experience from the global transboundary water resources management shows that negotiation and mediation water diplomacy approaches were adopted and used in resolving disputes over shared water resources. Additionally, civil society and other actors played a significant role in bridging the gap and creating a neutral platform for interaction between the riparian states that paved the way for cooperation. [5, 6].

The major problem is that the EN countries are giving less weight to the role of water diplomacy and its importance can resolve the disputes regarding sustainable management and development of Nile waters. By improving the role of informal water diplomacy on enhancing formal water diplomacy for the successful cooperation in benefit sharing and fair water allocation as well as for sustainable protection of the ecosystem and biodiversity of the Nile River. Track II water diplomacy can facilitate formal talking and conducting scientific studies to support formal diplomacy efforts (see Figure 1).

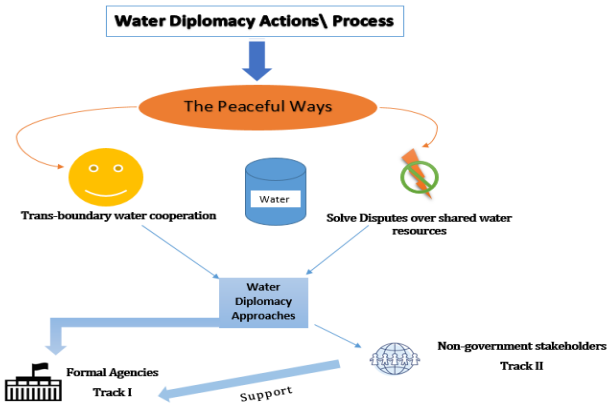

Figure 1: Hypothesis of the study:

The interview was held with a group of resource persons representing EN states from civil society, academicians, Government officials, NGO, and other stakeholders. The result from

the interview almost (51%) indicated that water diplomacy is the mechanism of how countries might negotiate among themselves and about 52% of respondents recommended that negotiation is the best approach to be practiced in the context of the Eastern Nile River basin (see figure 2). Moreover, the experience from the global transboundary water resources management shows that negotiation and mediation water diplomacy approaches were adopted and used in resolving disputes over shared water resources. Additionally, civil society and other actors played a significant role in bridging the gap and creating a neutral platform for interaction between the riparian states that pave the way for cooperation. The role of Civil Society in Jordan river (Peace agreement 1994: (Civil society, the Arava Institute of Environmental Studies (AIES), Middle East Desalination Research Centre (MEDRC), EcoPeace) [7]

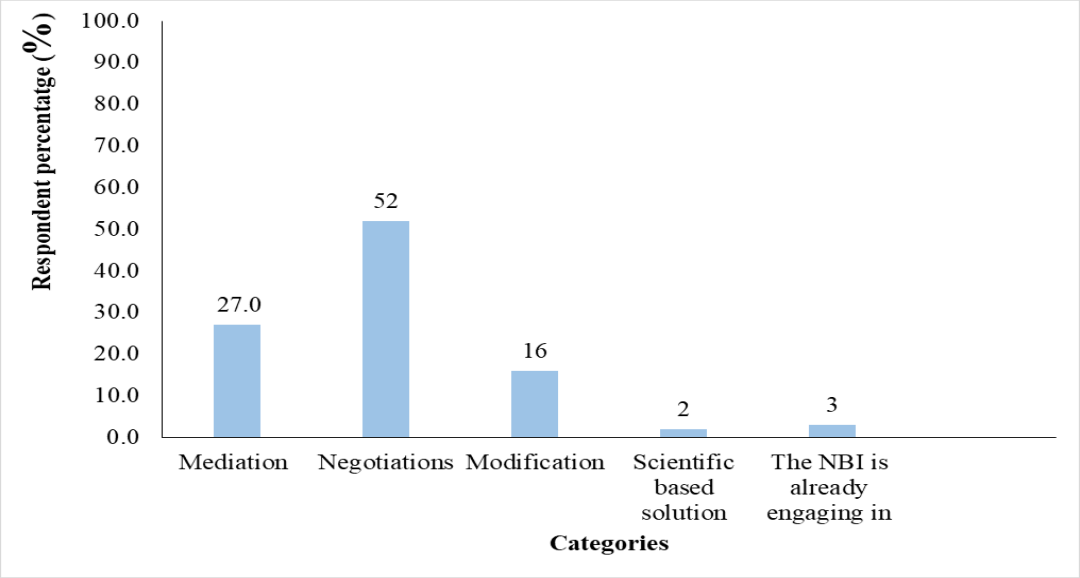

Figure2: The recommended water diplomacy approach in the context of Eastern Nile Basin and NBI (Nile Basin Initiative)

The finding of the study would recommend that the Nile Riparian Countries exert efforts to enhance the understanding of the water diplomacy, the role of the civil society and other stakeholders in the region through media, the internet, magazine, news, workshops, conferences, the platform that could influence the decision-making process. However, the Eastern Nile Countries need to follow the water diplomacy levels by incorporating the regional level to bind states to share understandings of acceptable practices around water, the intrastate level to incorporate ethnography of water users and civil society groups, and the communal level to employ disaggregated geo-referenced data on water resources in conflict-prone areas. Moreover, the establishment of a permanent commission with a mandate of addressing all technical, social, and political issues in the basin and carrying out the implementation of the treaty and benefit-sharing projects will be a great step toward resolving disputes in the Nile basin.

In conclusion, the study examines the water diplomacy approaches, types, and strategies practiced in the context of the Eastern Nile compared with those used in worldwide transboundary water resources management (e.g. Jordan River, Rhine, and other transboundary basins), and concluded the diplomacy approaches practices in the Eastern Nile did not address the interest and the needs of all riparian states. The study also found that

the role of the society and the other stakeholders are not significant in enhancing the formal negotiation in the region. Thus the countries are cooperating based on equitable sovereignty and territorial integrity rather than addressing the dispute in a holistic approach. Consequently, the Eastern Nile countries need to consider fair and reasonable use of water by considering environmental protection. Additionally, the exchange of information to protect against significant harm a basis for fair water allocation and cooperation that could distinguish between water as an environmental issue and water as a national security issue and should refrain from issues of control, jurisdiction, and sovereignty which are more complicated and lead to international dispute among the users.

The study would recommend that the Nile Riparian Countries exert efforts to enhance the understanding of water diplomacy, and the role of civil society and other stakeholders in the region through media, internet, magazine, news, workshops, conferences, and the platform that could influence the decision-making process. However, the Eastern Nile Countries need to follow the water diplomacy levels by incorporating the regional level to bind states to share understandings of acceptable practices around water, the intrastate level to incorporate ethnography of water users and civil society groups, and the communal level to employ disaggregated geo-referenced data on water resources in conflict-prone areas. Moreover, the establishment of a permanent commission with a mandate of addressing all technical, social, and political issues in the basin and carrying out the implementation of the treaty and benefit-sharing projects will be a great step toward resolving disputes in the Nile basin.

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Theme 3: Support Co-Benefits of Water Management Adaptation Actions and Economic Growth

The Assessment of Climate Change Impact on Major Crops in the Arab Region and Proposed Adaption Measures
Ihab Jnad , Mazan Naaman

Optimization of Graphene Oxide by Chitosan for Highly Efficient Coagulation/Flocculation Process of Contaminated Raw Surface Water
Abdelmeguid Aboubaraka , Eman F. Aboelfetoh, El-Zeiny M. Ebeid

Effective Nano-Membranes from Chitosan/PVA Blend Decorated Graphene Oxide with Gum Rosin and Silver Nanoparticles for Removal of Heavy Metals and Microbes from Water Resources
Emad M. Ahmed, Heba Isawi , Mohamed Morsy, Mohamed H. Hemida, Hesham Moustafa

Ultra-Sonication Treatment for Saline Groundwater: A New Innovative for Preventing Emitter Clogging in Surface Drip Irrigation Systems
Atef Ghandour , Fawzya A. Nagm Al Deen; Mohamed Y. El Ansary; and Montaser A. Awaad

Aqua Electrica: Harnessing the Hydropower for sustainable desalination and irrigation
Mohamed Ehab , Omar Waleed Mohamed Galal

Controlled Drainage Application and The Associated Sustainable Development Goals
Eman Hasan

Chitosan-G-Polyacrylonitrile Zno Nano-Composite, Synthesis and Characterization as New and Good Adsorbent for Iron from Groundwater.
Abdelrahman O.A. Eldenary , Hanafy Abd El-Salam, Abeer Enaiet Allah

The Use of Adsorptive Techniques and Biological Degradation for the Removal of Phenol from Wastewater.
Mohamed Elkasem, Adel A. M. Abdel-Aleem , Marzooka Shaban Abdel-Tawab, and Mohamed El-Kassem M. Hassouna

Eco-Friendly Chitosan Adsorbents for Removal of Methylene Blue Pollution from Aqueous Medium.
Hadeel El-Shorbagy , Hadeel G. El-Shorbagy

Theme 3: Support Co-Benefits of Water Management Adaptation Actions and Economic Growth

Isolation and Identification of Low-Density Polyethylene (LDPE) Biodegrading Bacteria from The Mediterranean Sea.
Donia Wafaa , Mahmoud Wafik, Kareem Tonbol

Assessing the Viability of In-pond Raceway Systems in Egypt: A Case Study.
Asmaa Abdelgayed , Eman Mohie El-Din, Hagar El-Qersh, Jasmine Tarek, Kholoud Mohsen, Mayar Hatem, Yehya Imam, and Mostafa Badawy

Evaluating the Use of the Chemically and Biologically Treated El-Rahawy Drain Wastewater in the Agriculture of Corn Crop.
Sahar Abd Elaziz Othman , Mona S. S. Soliman, Amal I. Ramadan

Cost model for upgrading electromechanical components in existing hydropower plants

Sara ElFaramawy, Ahmed M. Abdelsattar

Tracing TOC concentration and SUVA254 in surface water, treated water and wasted aluminum sludge

Mahmoud Mohamed Fouad Hussein

A Comparison of Commercial and Natural Activated Carbon Nano Sheets for Wastewater Treatment

Irene Fahim, Khlood A. Alrefaey, Nora Mohamed , Lobna A. Said, and Ahmed G. Radwan

Microbial bioremediation of olive mill wastewater enhanced by zerovalent iron Nano-particles

Ahmed Abdel Azeiz, Nahla Moftah and Hala Eissa

Adsorptive recovery of arsenic (III) ions from aqueous solutions using dried Chlamydomonas sp.

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The Assessment of Climate Change Impact on Major Crops in The Arab Region and Proposed Adaption Measures

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Keywords: climate change, crop yield, crop water requirement, growth cycle
CWW2023 Theme: 3

ABSTRACT

As climate change intensifies, the Arab region is expected to experience increased challenges related to water resources, including providing safe drinking freshwater; satisfying the requirements for agriculture and industry; ensuring environmental sustainability and appropriately managing shared water resources. Extreme weather events are expected to increase in frequency and variability, and take an increasing toll on the Arab region's fragile ecosystems and its overstretched water resources. Climate change may affect agriculture due to changes in temperature, precipitation, soil moisture, increased atmo-spheric carbon dioxide levels and an increase in the probability of extreme events such as droughts, extreme heat waves, heavy rainfall, cyclones, flooding of the coastal areas, erosion etc

Outputs from the Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR) shows that projected climate changes in the Arab region will include increases in temperatures, changes in precipitation patterns, changes in extreme weather events, and reductions in water availability. Since growth and development of crops are mainly dependent on temperature, and water availability, the projected change in climate will substantially affect productivity of major staple food crops in the Arab region such as wheat, rice, maize, and sorghum. The increase in temperature could affect significantly the cropping patterns, crop yields and phenology and could cause reduction of the growing period. In addition, expected precipitation reductions in many areas of the region where water is already limited, can have dramatic impacts on crop production. Extreme events, especially floods and droughts, can harm crops and reduce yields. Although higher CO_2 levels can positively affect crop yields, other aspects, such as water and nutrient constraints, may reverse these potential increases in yield.

This study was implemented in cooperation among The United Nations Economic and Social Commission for West Asia (ESCWA), The Food and Agriculture Organization of the United Nations (FAO), and the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD)

in aim to Assess Impacts of Changing Water Availability on Agricultural Production in selected countries in the Arab region

The study was implemented in 10 target countries: Egypt, Iraq, Jordan, Lebanon, Morocco, Palestine, Sudan, Tunisia, Yemen, and Bahrein.

In order to obtain a complete understanding of the future impacts of climate change on crops in the region, there is a need to integrate climate change projections with a crop growth model.

Climate growth models are very useful tools to simulate the important aspects of the behaviour of crops under climate change condition. This will help better understand how climate change could affect food production in the different countries of the region.

In this study, the projected effects of climate change on major crops in different Arab countries were assessed at the mid (2044-2065) and the end (2081-2100) of the running century. The prediction was based on the implementation of AquaCrop under Two emission scenario RCP 8.5 and RCP4.5. The assessment methodology involved the following steps:

1. Collection of observed climate data for at least one location in each of the three target area;
2. Extracting future climate change data to the end of the century (2100) period under RCP4.5 and RCP4.5 emission scenarios obtained from climate modelling performed within RICCAR project
3. Calibration of crop models for simulating crops;
4. Collection of soil and crop management information for the target area; and
5. Simulating long-term crop yields under baseline and future climate scenarios.

The targeted crops utilized in this study included irrigated and rain-fed wheat, irrigated and rain-fed sorghum, sesame, maize, tomato, potato, and sugar beet were utilized in assessment. Assessment procedures included data collections for the AquaCrop model (climate, soil, crop, fertility, irrigation, etc.) and observed yield data, where observed and simulated yields were compared.

Table 1 and table 2 shows results of the impact of climate change on rainfed wheat (at Karack Governorate -Jordan) and irrigated wheat (at north Delta – Egypt)

Table 1- Average baseline yields of wheat at Karack Governorate -Jordan and predicted average change in it according to the RCP8.5 scenarios without inclusion of elevated CO2 effects

	Average change at midcentury (2046-2065)	Average change at the end of the century (2081-2100)
Baseline Yield (ton/ha)	1.41	
Absolute change (Ton/ha)	-0.1	-0.8
Relative change (%)	-5.2	-55.3

Table 2 - Average baseline yields of wheat at north Delta – Egypt and predicted average change in it according to the RCP8.5 scenarios without including elevation of atmospheric CO2 concentration

	Average change at midcentury (2046-2065)	Average change at the end of the century (2081-2100)
Baseline Yield (ton/ha)	6.46	
Absolute change (Ton/ha)	-0.3	-0.4
Relative change (%)	-4.0	-5.5

In general, it has been found in this study that climate change will have the following impacts on crops:

- Crop yields will decline and crop growth cycle will decrease
- Rainfed crops will be more sensitive to climate hang than irrigated crop
- Thermal stresses appeared as a result of climatic changes in autumn and summer crops and did not appear in winter crops.
- The results showed an increase in daily water consumption for all studied crops as a result of climatic changes,

- A rise in the need for water of irrigated crops by 7-12 per cent
- The changes in yield were not homogeneous for the studied crops and depended on the phenology of the crops
- Increasing atmospheric CO_2 concentration is likely to have some positive effect on yield Plants produce more vegetative matter as atmospheric concentrations of CO_2 increase. The effect depends on the nature of the photosynthetic process used by the plant species. So called C3 plants use CO_2 less efficiently than C4 plants so C3 plants are more sensitive to higher concentrations of CO_2

Optimization of Graphene Oxide by Chitosan for Highly Efficient Coagulation/Flocculation Process of Contaminated Raw Surface Water

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Key words: Coagulation/flocculation, Dyes removal, Disinfection by products, Sludge reusing
CWW2023 Theme: 3

ABSTRACT

This study investigates the performance of the recently applied binary coagulation system consisting of graphene oxide (GO) as a main coagulant and chitosan (CS) as a natural coagulant aid for raw contaminated surface water. This is considered a brilliant alternative to the more common coagulant used in water treatment (alum) to reduce the environmental aluminum release. Aluminum ingestion by humans has been connected with several probable neuropathological diseases including presenile dementia and Alzheimer's disease [1, 2]. GO has already been applied for removing turbidity from real surface water of Elkased conduit, Tanta, Egypt [3]. The utilization of CS application as a coagulant aid enhances the effectiveness of GO in eliminating naturally occurring impurities like turbidity, bacteria, and algae from surface water sources. Furthermore, the newly developed GO/CS system has been successfully employed to eliminate industrial pollutants such as dyes and heavy metals.

GO was synthesized by the oxidation of graphite in the absence of $NaNO_3$. The structure of GO and GO/CS was confirmed by different techniques such as powder X-ray diffraction, FTIR spectra UV-Vis spectra, and Surface morphological analysis performed using TEM. The jar test was used to verify the coagulation properties of GO and GO/CS. The exact and residual concentration of GO was affirmed by the UV-Vis spectrophotometer at a wavelength of 225 nm. The disinfection by-products (DBP) resulting from chlorine application in the water purification process were investigated in the presence of GO and (GO/CS). Trihalomethane (THM) compounds were selected, representing the largest percentage of DBP resulting from the chlorination process.

The exceptional coagulation properties of GO/CS have been observed in the removal of natural and industrial pollutants from contaminated surface water. The GO/CS coagulation system demonstrates effective performance over a wide pH range (pH 4-10), with optimal results achieved at (pH 4-8). CS exhibits the capability to eliminate residual GO particles from treated surface water after the coagulation/flocculation process, regardless of the pH values. By adding 0.5 mg/L CS to 12 mg/L GO, the efficiency of algae removal exceeds 99%, while the removal of FCB (Fecal coliform bacteria) and HB (heterotrophic bacteria) from natural surface water reaches over 87% and 90%, respectively. These percentages can be further increased to 95% and 97% by increasing the concentrations of both GO and CS. The coagulation process using GO/CS for dye removal is influenced by the concentrations of GO/CS and the initial pH value. GO/CS exhibits complete removal capability for DB2 (Direct brown 2) dye across all pH

levels, depending on the doses of GO, CS, and initial dye concentrations. The removal capacity for MB (Methylene blue) is 80%, which can be enhanced by increasing the concentrations of GO/CS. Pb^{2+} removal using 16GO/2CS mg/L achieves a removal efficiency exceeding 61% at an initial Pb^{2+} concentration of 9 mg/L.

To compare the effects of chlorine addition, both GO and GO/CS systems were subjected to chlorine treatment. Results indicate that there is no significant interaction between GO and CL_2 at low doses, and the reaction between CL_2 and GO begins when the GO dose reaches 12 mg/L and 5 mg/L of CL_2. At Cl_2 doses 5 and 6 mg/L, the concentration of THMs produced with 12 mg GO coagulant (64.55 and 67.31 µg/L) surpasses that in the presence of Cl_2 without coagulant (57.9 and 60.7 µg/L). Therefore, the use of chlorine as a disinfectant agent in combination with GO is safe according to WHO and EPA guidelines. In the case of GO/CS, the formation rate of THMs is lower than when using either GO or Cl_2 alone across all Cl_2 concentrations. In the coagulation process using GO/CS, THMs increase with increasing Cl_2 doses until reaching 5 mg/L of chlorine, resulting in a TTHM concentration of 50.13 µg/L. Beyond this value, the formation rate of THMs remains relatively constant or even decreases as shown in Fig 2E.

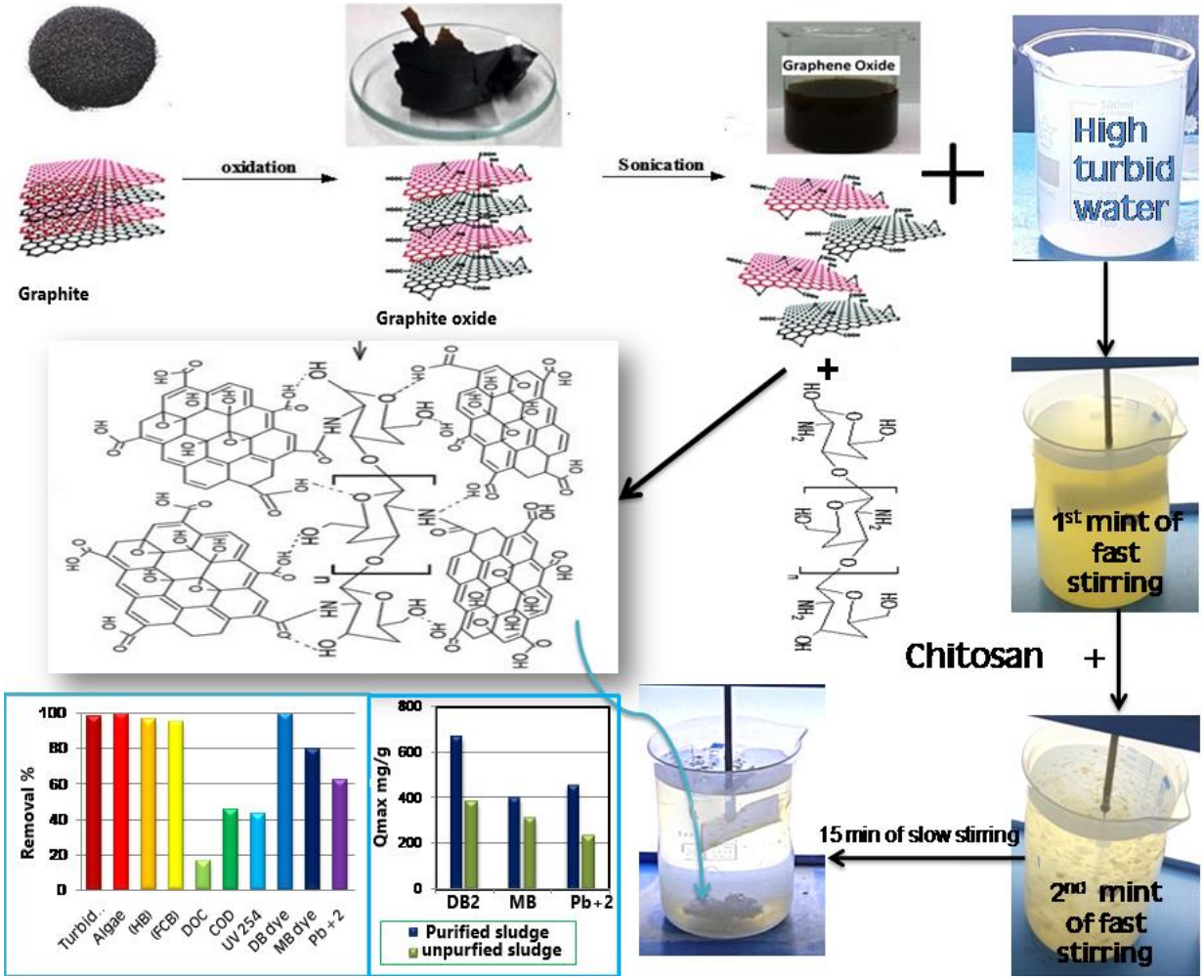

Figure 1: Graphical abstract shows the diverse steps during coagulation/flocculation process by GO/CS up to the last minute of the process beside its impact on various pollutants.

Considering the economic aspect, the sludge generated during the coagulation/flocculation process has been effectively utilized as an adsorbent for further removal of dyes and Pb (II)

ions. The maximum adsorption capacities (Q_{max}) of the purified GO/CS sludge were found to be 667, 400, and 454 mg/g for DB2, MB, and Pb^{2+} respectively. These Q_{max} values surpass those of many recently employed adsorbents, indicating the high efficiency of the GO/CS sludge for adsorption purposes.

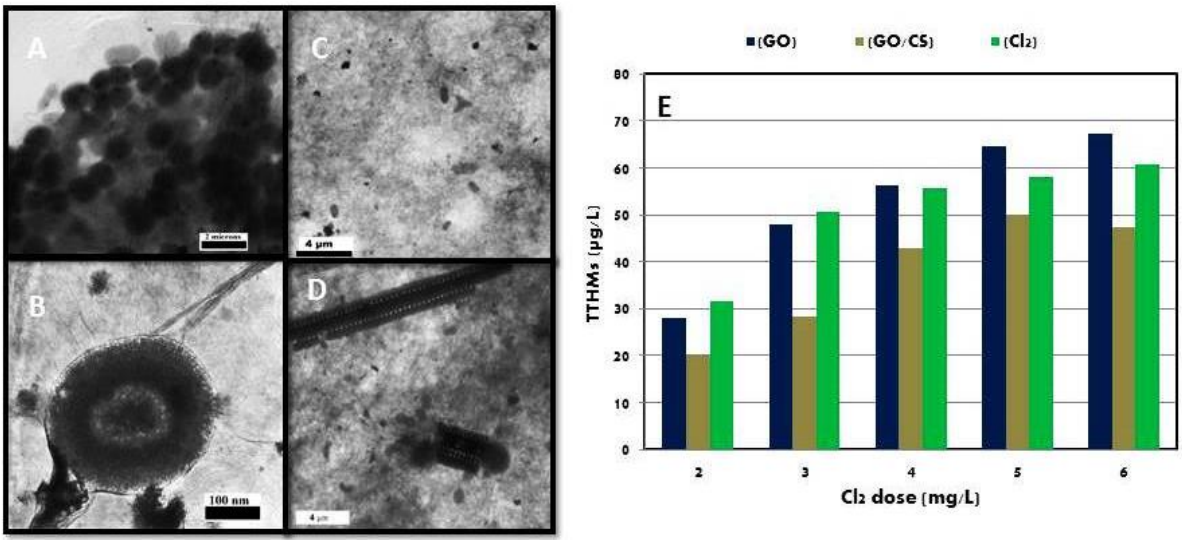

Figure 2: TEM images of GO after coagulation process show the synergetic effect of it on bacteria (A Wrapping, B perturbation of the cell membrane), TEM image of GO/CS binary system wrapping different contaminants during coagulation/flocculation process (C, D), the formation of TTHMs resulting from using different doses of chlorine in case of GO, GO/CS system and Chlorine dosing without coagulant (E).

Conclusion

The new system (GO/CS) displayed a high capability to remove turbidity (>98%) and biological contaminants such as algae (>99%) and bacteria (>95%). Furthermore, the coagulation system displayed an excellent ability to remove dyes DB2 (100%), MB (80%), and lead ions (>60%) from contaminated raw surface water. The new system GO/CS doesn't leave any residue after the coagulation process at a pH range (of 4 to 10). The application of chlorine for disinfection purposes with a GO/CS system is a safe process and reduces DBP resulting from CL_2 interaction with organic matter. The sludge utilizing of GO/CS binary system will make the coagulation process not just a highly effective purification process but also a production process of the highly efficient adsorbent. Thus, this system will be economically effective and will take great attention from water workers all over the world.

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Effective Nano-Membranes from Chitosan/PVA Blend Decorated Graphene Oxide with Gum Rosin and Silver Nanoparticles for Removal of Heavy Metals and Microbes from Water Resources.

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Keywords: Graphene oxide, Chitosan/polyvinyl alcohol, Gum rosin/Ag NPs Nanomembrane, heavy metal, Generation. Water remediation
CWW2023 Theme: 3

ABSTRACT

Many developing nations are currently dealing with significant water shortages as a result of climatic changes, rapid population increase, and an expanding economy [1]. The removal of heavy metals from food or water samples is insufficient because bacteria, fungus, and other pathogens are thought to be common in water, soil, and plant materials and can lead to outbreaks of food and water poisoning that induce diarrhoea or vomiting [2]. Therefore, it is imperative that they be removed from the water supplies in order to prevent the present pandemic diseases. Making a powerful bio-adsorbent based on functional spots may certainly remove many pathogens and heavy metals from contaminated water resources [3].

Therefore, the goal of this study was to create depollution bionanomembranes by solvent-casting decorated graphene oxide (GO) with antibacterial natural rosin and silver nanoparticles (Ag NPs) inside a chitosan/polyvinyl alcohol blend, Figure (1). In the present research, we utilize a facile and green functionalization of GO nanoplatelets by antimicrobial natural rosin and Ag NPs using In-situ approach. This approach is considered to prepare a high-efficient bio-adsorbent for elimination of heavy metals and microbes from varying water resources with affordable cost. The decorated GO nanoplatelets are amalgamated inside CS/PVA blends with variable ratios ranging from 1 to 3 wt.% by solvent-casting route without requiring an interlocking agent. The nanostructure of decorated GO nanoplatelets and the surface topography of the fabricated CS/PVA nanomembranes are investigated by XRD and SEM observations. Other measurements such as mechanical, adsorption efficacy,

thermal stability, bacterial colony count, and antibacterial properties are conducted on the casted CS/PVA nanomembranes. Furthermore, kinetic and isothermal models for optimal CS/PVA-3% NPs membrane are also proposed to identify the adsorption efficacy of the membrane.

According to the results, using ornamented GO, especially at a 2 weight percent concentration, enhanced the blend's tensile strength from 33 MPa to 48 MPa. On the cast CS/PVA nanomembranes, tests are also done for thermal stability and antibacterial qualities. Additionally, the adsorption of heavy metals into polymeric membranes at room temperature and pH 4-6 is investigated in terms of heavy metal depollution. The obtained results showed that, in comparison to other nanomembranes, the CS/PVA-3% NPs membrane had a greater adsorption property towards the selected metal ions (i.e., 85-99.7% depending on the metal ion type). However, the nanomembrane containing 2 wt.% of nanoplatelets attained the highest tensile strength. In addition to the recovery and reusability of the adsorbent, the effects of pH, temperature, contacting time, and bacterial colony counting on CS/PVA-3% NPs are also investigated. In order to illustrate the effectiveness of the CS/PVA-3% NPs membrane's adsorption, kinetic and isothermal models are also suggested. The information received indicated that CS/PVA-3% membrane is an effective method for removing biological species and heavy metals from water resources used for irrigation and agricultural purposes.

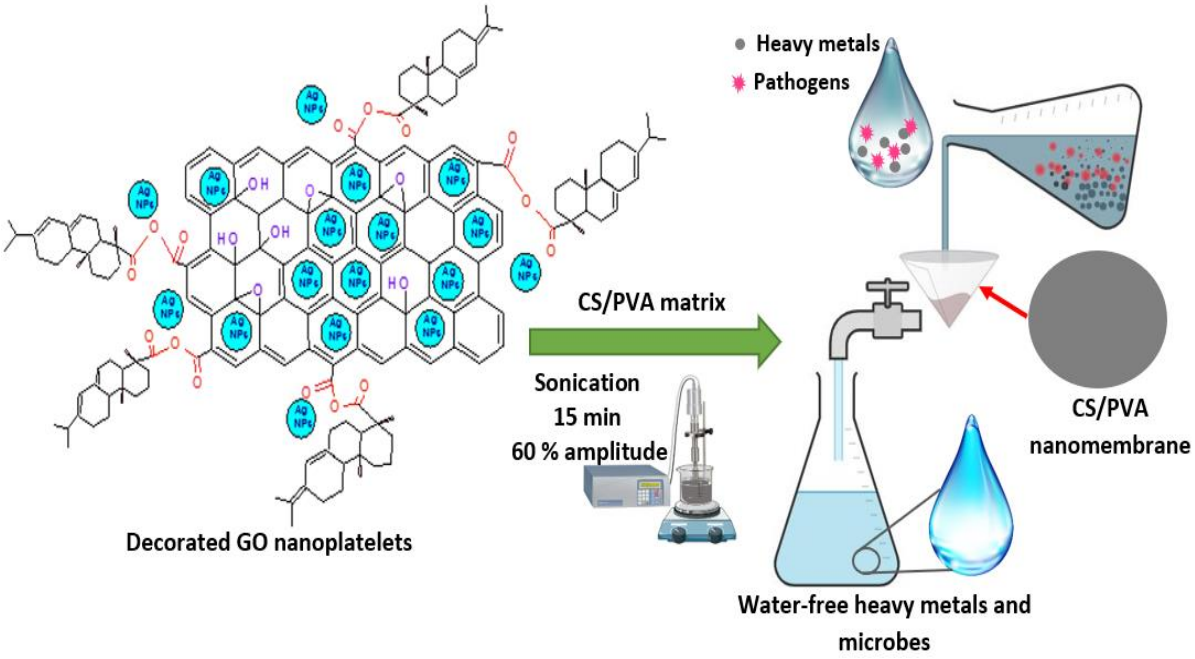

Figure 1. Decorated GO nanoplatelets by antimicrobial natural rosin acids and Ag NPs as a novel biomaterial for boosting the properties of CS/PVA nanomembranes

Conclusion

In the current study, a successful solvent-casting method is used to manufacture an efficient dual nature heavy metals and bacterial bio-adsorbent nanomembrane from decorated GO with antibacterial natural rosin and Ag NPs inside CS/PVA blend. By creating these biopolymeric nanomembranes without the need of an interlocking agent, a more environmentally friendly method is used to capture pathogens and heavy metals from various water bodies. For adsorption studies, the results showed that the optimal CS/PVA-3% NPs

membrane is fulfilled at 3 wt.%, and its elimination efficiency reached the maximum at the optimal pH value of 4-6 according to the type of metal ions, 25 $^{\circ}$C, 60 minutes, and the optimal adsorbent dose is 2 g/L as 96.5, 90, 85, 99.7, 88, 93.5, 95, 89, 96, 99.7, and 96.5 for Al^{3+}, Cd^{3+}, Co^{2+}, Cr^{3+}, Cu^{2+}, Fe^{3+}, Mn^{2+}, Ni^{2+}, Pb^{2+}, Sr^{2+}, and Zn^{2+}, respectively. The EDX measurement, which checks the retention of metal ions on the membrane surface modified with 3 weight percent of decorated GO, supports these findings. The Al^{3+}, Cd^{2+}, Cu^{2+}, Ni^{2+}, Pb^{2+}, Sr^{2+}, Cr^{2+}, and Zn^{2+} metal ions are confirmed to be adsorbed onto CS/PVA-3% NPs membrane as a monolayer treatment with a uniform adsorption surface using the Freundlich, Temkin, and Langmuir isothermal models. Chemisorption is the primary adsorption process. While the heterogeneous sorption process is used to adsorb the metal ions Co^{2+}, Fe^{3+}, and Mn^{2+}. Selected metal ions' RL values are greater than zero and less than unity, indicating favorable adsorption. The adsorbent/adsorbate interactions employing the CS/PVA-3% NPs membrane were found to have a homogeneous distribution of bonding energies. Furthermore, the selective metal ion adsorption into the CS/PVA-3% NPs membrane, which represents conventional chemical adsorption, was accurately predicted by the POS kinetic model.

The obtained results demonstrated that the synthetic CS/PVA-3% NPs membrane is anticipated to be a secure, simple, and environmentally sound technology for wastewater remediation, improving removal efficiency, and cost-efficient technology for reducing the biological species in wastewater operational procedures, and achieving an ideal potential for improving the groundwater quality in El-Kharga Oasis of the New Valley, Egypt.

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Ultra-Sonication Treatment for Saline Groundwater: A New Innovative for Preventing Emitter Clogging in Surface Drip Irrigation Systems

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Keywords: clogging, drip, irrigation, emitter, saline groundwater, and Ultrasonic.
CWW2023 Theme: 3

ABSTRACT

Clogging is a grievous problem in drip irrigation, especially using saline groundwater; this may cause uneven water distribution. In this study, an innovative, environmentally-friendly technology using Ultrasonic waves with radio frequency, without any chemicals for treating emitters clogging. The objectives of this study were to evaluate the chronological changes in the emitter flow rate and the effect of Ultrasonic (US) water treatments on solving the problem of emitter clogging in the field. The performance of the drip irrigation system was tested by measuring the emitter discharge and estimating the average emitter discharge (qav), coefficient of variation (CV), distribution uniformity of the lowest quarter (DUlq), the application efficiency (AE), and Christiansen uniformity coefficient (CUC). The results indicated that the qav for the emitters improved from 3.37 l/h before treatment to 4.1l/h after 180 h of US irrigation water treatment. The DUlq and the AE of the drip irrigation system were 76.7%, and 69.10% respectively before treatment, and due to the presence of high salts in the groundwater which caused emitter clogging. After 180 h of US water treatment, DUlq and the AE improved to 90.3% and 81.27% respectively. This improvement led to saving about 15% of the daily irrigation water. This study proves that ultrasonic water treatment is a highly effective, chemical-free treatment method with great potential for preventing emitters from clogging a drip irrigation system.

An ultrasonic generator energizes the transducers. The generator transforms the electrical energy from the power source into a suitable form for efficiently energizing the transducers at the desired frequencies.

The transducer is a piezo-ceramic material that changes shape instantly when excited by an electric signal. When excited by a high-frequency electronic generator, the transducer

vibrates at a resonant frequency and induces amplified vibrations of the diaphragm. This causes a series of compressions and rarefactions in the liquid in the tank or hose.

When transmitted through water, these pressure waves create the cavitation process. The resonant frequency of the transducer determines the size and magnitude of the resonant bubbles. The lower frequency produces larger bubbles with more energy. The more powerful the cavitation process, the larger the imploding bubbles. The higher the frequency, the less aggressive is cavitation and the smaller the implosions

This system saves a lot of money, effort, and time because it does not require adding chemicals to the irrigation network to remove the salts deposited in the emitters, thus reducing the cost of the labor used in cleaning and wiping the emitters. Compared to the price of the device, the price of the device is very low in terms of cost in relation to the cost of chemicals and labor used in maintaining the drip irrigation network. As the cost of the device is approximately 40 thousand pounds, it can be used on approximately five acres, and the cost per acre is about 8,000 pounds for the life of the device up to 10 years (about 800 EP/acre/year).

Materials and Methods:

The MAX GROW is an electronic water treatment system (Figure 1) using multiple transmissions of Ultrasound waves (US) with radio frequencies (RF) to tackle the problems caused by saline water. It works by generating up to a million vibrations per second, and it differentiates the mineral salts to produce safe, easily removed by-forms.

Figure 1. The MAXGROW water treatment technology system.

The groundwater treatment was obtained by passing irrigation water through the device installed on the sub-main line of well water of 100 m3/h discharge as shown in Figure 1. A laboratory evaluation of new drippers was carried out at the National Irrigation Laboratory of Agricultural Engineering Research Institute (AEnRI), ARC, Dokki, Egypt according to American Society of Agricultural Engineers ASAE EP405.1., (2003) [1].

Results and Discussion:

The effect of US water treatment on the Distribution Uniformity of the lowest quarter (DUlq) and the water Application Efficiency (AE) of the drip irrigation system under saline water conditions are summarized in Figure 2.

The results indicated that the (DUlq) of the one-year-old drip irrigation system was 76.7%, and according to the evaluation standards of the drippers, the distribution efficiency of the system was poor as a result of the high clogging rate occurred.

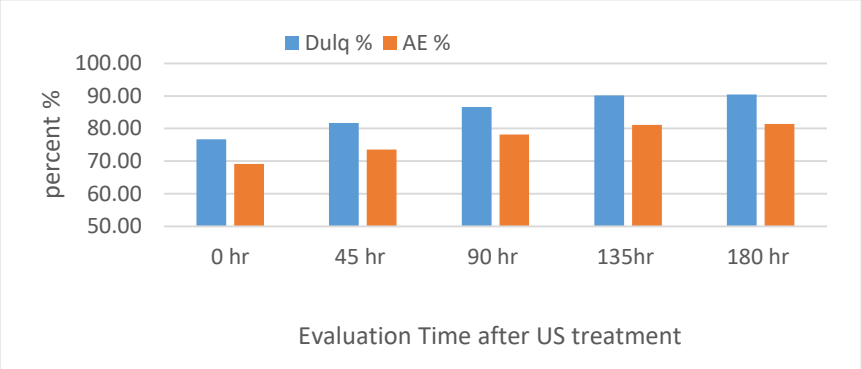

Figure 2. effect of US water treatment on DUlq % and AE%.

Accordingly, the Application Efficiency (AE) of the drip irrigation system was as low as 69.10% before the US treatment process, due to the accumulation of salts occurs over time inside and outside the emitters, which causes emitters to clog and reduces its flow rates.

The Results of the ultrasonic treatment process, as presented in Figure 2, indicated that after 45 h of treatment, the DUlq increased from 76.7% to 81.7, which also reflected in the water Application Efficiency (AE) as it was increased from 69.1% before treatment to 73.5% after US treatment.

As the ultrasonic water treatment process continues, the efficiencies of the drip irrigation system improved. From Figure 2, the result showed that after 135 hours, the DUlq increased from 76.7% before treatment to 90.1%, which is considered a significant increase, due to the ultrasonic effect on reducing emitters clogging from 44.6% to 14.6% after 135 operating hours. Consequently, all the Ultrasonic effects mentioned above resulted in improving irrigation water Application Efficiency from 69.1% to 81.4 after 135 hours of operation, and this indicates a saving of water about 15.1% from the irrigation water daily, as calculated according to the (Wu and Gitlin, 1983) [2] equation (1).

$$\textbf{Percent of saved water} = \{1-(AE1/AE2)\} \times 100 \quad (1)$$

$$\textbf{Percent of saved water} = \{1-(69/81.27)\} \times 100 = 15.1\%$$

Conclusion:

The use of ultrasonic technique (MAX GROW) has been tried as a modern environmentally friendly technology in solving the drip irrigation emitters clogging problem. This technology has proven its effectiveness in eliminating dripper clogging, which leads to improved water distribution uniformity and increased application efficiency of the drip irrigation system. This Ultrasonic treatment of underground saline water used in drip irrigation of sandy soils could be a promising technology for agricultural development in the newly reclaimed areas in Egypt. Based on this research results, it is recommended to use safe ultrasonic (US) technology in saline water treatment to improve the uniformity of water distribution and the application efficiency of drip irrigation systems due to its ability to solve emitters clogging problem.

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AquaElectrica: Harnessing the Hydropower for Sustainable Desalination and Irrigation.

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Keywords: Energy production, Greenhouse gases, Hydropower, Triboelectric Nano-generators, Water desalination.
CWW2023 Theme: 3

ABSTRACT

Earth's surface is predominantly covered by water, with a staggering 97.2% comprising saline water, leaving only a meager 2.8% as freshwater resources. Among this freshwater fraction, over 2.1% is locked away in glaciers, the atmosphere, and soil moisture, rendering a mere 0.7% accessible for human and agricultural use [4].

The challenge of water scarcity has intensified due to inadequate integrated water resources management and the complex impacts of climate change. Greenhouse gas emissions play a pivotal role in exacerbating this global water crisis. Our research is dedicated to the imperative reduction of these emissions, with a specific focus on two dominant sectors contributing to approximately 38% of global greenhouse gas emissions: energy production and agriculture. This endeavor has garnered heightened attention to the pressing issues of global water scarcity. In Egypt, the per capita annual water supply is projected to decrease from 550 m3 to a mere 500 m3 by 2025. Given Egypt's extensive coastline of about 3000 km, desalination has emerged as a promising solution for augmenting freshwater resources [4].

Numerous innovative approaches have been developed to enhance the sustainability of seawater desalination, reducing energy consumption while integrating electricity generation. One such approach involves the microbial desalination cell, which, although promising, faces formidable obstacles, including the exorbitant cost of its ion exchange membrane and relatively modest energy output [1]. In response to these challenges, our project consists of two core components. The first component aims to harness hydropower by leveraging the triboelectric Nano-generator (TENG) principle. This involves the juxtaposition and separation of materials with substantial electronegativity differences, inducing electron flow and generating electrical current during their separation. The second component integrates an electrolytic desalination cell meticulously designed to overcome conventional system limitations.

The incorporation of a cost-effective ion exchange membrane, priced at a mere 10% of traditional counterparts, further augments our system's functionality.

In pursuit of enhanced irrigation efficiency, we introduce a sophisticated smart irrigation system equipped with soil humidity sensors

Our research methodology unfolds through two distinct phases:

Phase One: Implementation of the Rotary TENG System

In this inaugural stage, we meticulously constructed our Rotary Triboelectric Nano-generator (TENG) system. It featured a helical fan measuring 35 cm in height and 0.635 cm in diameter, ingeniously designed to channel the flow of water and induce fan rotation. The entire assembly was encased within a glass container, measuring 45 cm in height, 20 cm in length, and 20 cm in width. The fan was securely affixed to a central shaft. Material selection was guided by the Triboelectric Series, which delineates electronegativity disparities among materials. Consequently, we opted for a combination of polytetrafluoroethylene (PTFE) and copper, along with aluminum. PTFE films, in tandem with copper, were skillfully attached to the shaft to harness the kinetic energy generated by the flowing water. Ensuring optimal electrical contact, a strategically positioned copper plate within the shaft facilitated the accumulation of charges. Further enhancing electron conduction from the PTFE/copper films to the external circuit, two carbon brushes were meticulously affixed to maintain contact with the copper plate. Subsequently, the rotating PTFE/copper plate came into contact with fixed plates arranged within a framework, supported by four rods that accommodated PTFE/aluminum films.

Phase Two: Construction of the Electrolytic Desalination Cell

The second pivotal phase of our project centered on the construction of an electrolytic desalination cell. This meticulously crafted cell was fashioned from acrylic sheets, measuring 45 cm in length, 15 cm in width, and 15 cm in height.

For the fabrication of the ion exchange membrane, we opted for a composition ratio of 2:1, blending Poly-Vinyl-Alcohol (PVA) and Poly-vinyl-pyrrolidone (PVP) [3]. The resulting solution underwent a meticulous 48-hour drying process. Subsequently, we prepared a cross-linking solution, comprising 100 mL of 2% glutaraldehyde, 50 mL of HCl as a mineral acid, and 200 mL of acetone. Immerging the polymer base in this cross-linking solution, we allowed it to harden for a duration of 40 minutes. In parallel, for the functionalization of the anodic membrane, we engineered a 10 wt. % KOH solution to facilitate the anodic reaction [2]. Similarly, the cathodic membrane functional group was meticulously crafted using a solution containing 4 wt. % of Boric Acid, enhancing membrane selectivity [2]. The polymer base was then immersed in both the anodic and cathodic solutions, maintained at a precise temperature of 60 °C for an exacting duration of 3 hours.

Following the meticulous assembly of the prototype, comprehensive testing protocols were executed. The initial phase showcased the system's capacity to generate 69 V, delivering 480 watts of power output, all under the steady flow of water at a rate of 33 L/min and operating under a 10 Ω load. This significant achievement is documented in Figure 1 and Figure 2. Subsequently, we subjected the system to a 10-day testing during the second phase. In this phase, we employed seawater. The results comprehensively detailed in Figure 3.

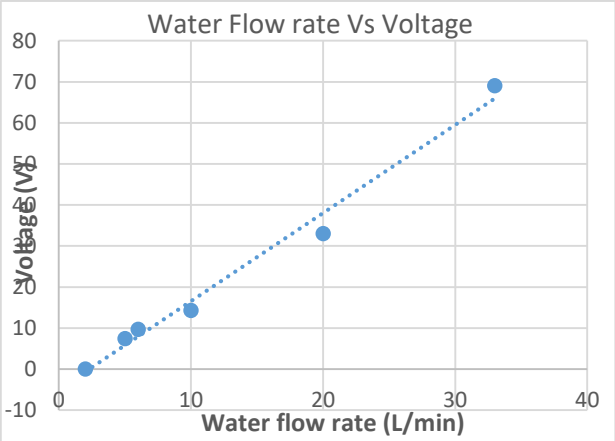

Figure 1. Water flow rate Vs Voltage

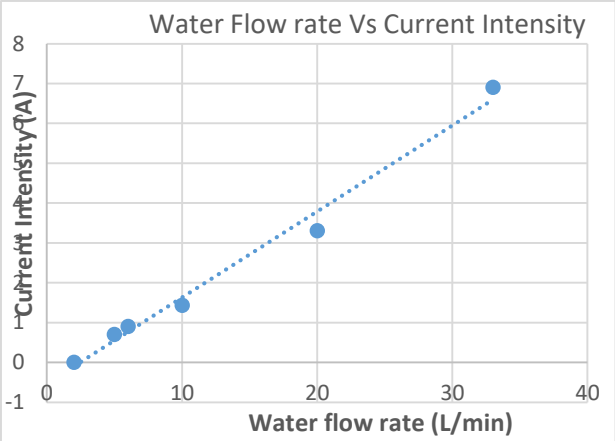

Figure 2. Water flow rate Vs Current

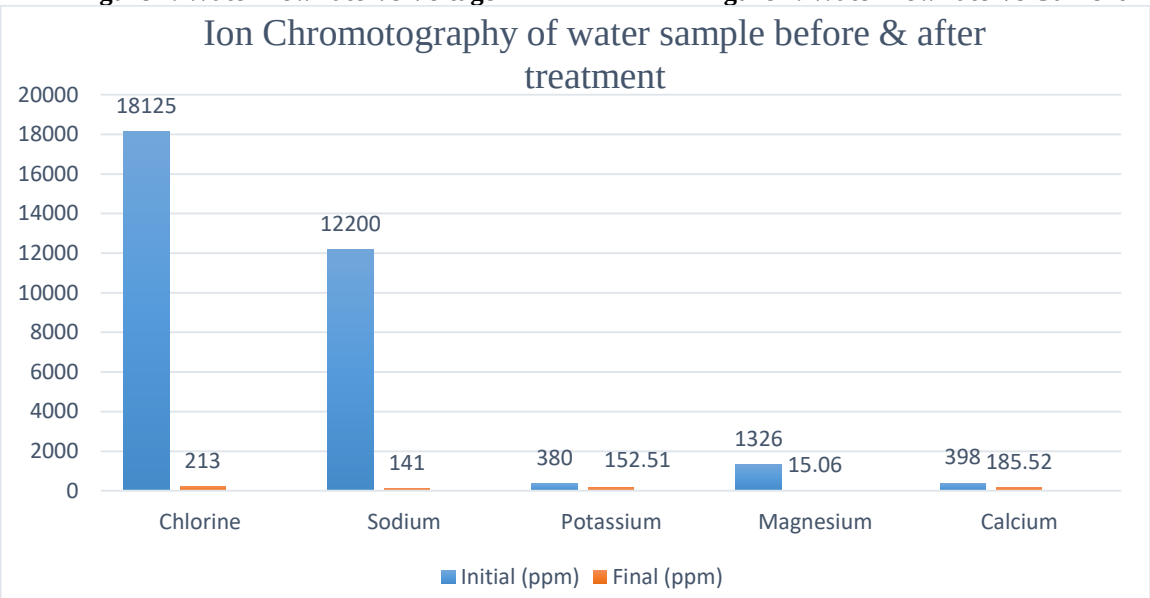

Figure 3. The initial and final concentration of real sea water samples after 10 days testing

In conclusion, TENG stage is 30 % efficient than the traditional dynamo. The desalinated is valid for irrigation exhibits satisfactory performance for irrigation purposes, particularly for potato crops, meeting the requirements outlined by the FAO.

Acknowledgment

The authors would like to thank Obour STEM school administration for their remarkable enhancement of the project, also we have to thank Allah and our parents for their support.

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Controlled Drainage Application and The Associated Sustainable Development Goals

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Keywords: Crop yield, Controlled drainage, Sustainable Development Goals, Water saving, Nutrient loss
CWW2023 Theme: 3

ABSTRACT

Controlled drainage (CD) is a technique for regulating the water table level; control the discharge of drainage water using a control structure which is installed in the drainage outlet. CD could be applied in agricultural areas that have subsurface drainage systems with suitable access points to subsurface drains' outlets, such as manholes or weirs in the open collector ditch. The objective of this research is to provide an overview of research conducted on CD worldwide and its impact on water saving, nutrient losses and crop yield. The potential of achieving several Sustainable Development Goals (SDGs) by applying CD was investigated. CD and its environmental impact are reviewed worldwide (Egypt, USA, Europe and Asia). The research results proved that in Egypt compared to free drainage (FD), CD saved irrigation water by 43% in rice fields and reduced Nitrate-N losses in drainage water by 73%, and 32% during the summer and the winter seasons respectively in western Nile Delta. In Nekla and El Baradei pilot areas CD proved it's effective in saving irrigation water by 28% in rice for year 2018 and 15.6% in wheat cultivation for year 2020. In USA, CD is an effective method for reducing nutrient loadings and increasing corn and soybean yields. In Europe CD reduced nitrate and phosphorus losses by a range from 20% to 51% and 40% to 46 %, respectively. In Asia (India), CD saved irrigation water by 17% in rice cultivation and reduced nitrate losses by 50.4%. In Iran, CD saved irrigation water by a range from 19% to 30% for wheat, maize and barley and reduced nitrate losses by a range of 37 % to 72%. CD application leads to five goals of the seventeen SDGs that adopted by the United Nations in 2015: SDG 2, SDG 6, SDG 7, SDG 8 and SDG17. These goals related to productive and sustainble agriculture, efficient water management, improving energy efficiency and economic productivity, and effective capacity building in developing countries.

Controlled Drainage Technology

In the Controlled Drainage (CD), the out level is typically changed several times during the growing season by changing the weir setting, Fig. (1), in response to daily fluctuation in rainfall and evapo-transpiration [1]. The hatched area is the quantity of water saved during one cycle. In the CD, drainage occurs as long as the water table in the field is at a higher elevation than that of the weir at the control structure.

Studies of Controlled Drainage Worldwide

CD and its environmental impact are reviewed worldwide (Egypt, USA, Europe and Asia). Also, the potential of achieving several Sustainable Development Goals (SDGs) related to

water management and crop production associated with CD application was investigated [2]. CD is applied in several study areas in Egypt that are cultivated with rice or dry-foot crops, Figure (2). There are some important differences between CD for rice and dry-foot crops. For rice, where the objective is to keep the water table as close to the soil surface as possible, a drain-blocking device can be used, which is opened frequently to refresh the standing water. For dry foot crops, a movable outlet used to control the water table level below a level at which waterlogging in the root zone would affect crop production. The movable outlet is used in composite subsurface pipe system. Although an "on/off" blocking device can be used, control is best achieved with a weir depth at a safe level when the collector drain is an open ditch.

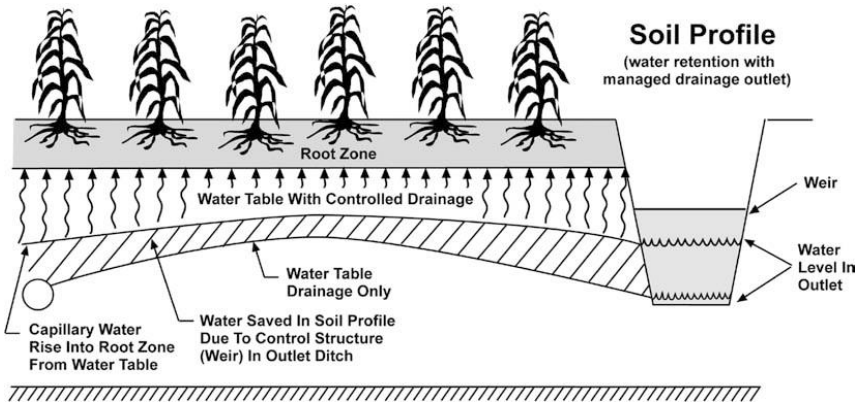

Figure1. Water level fluctuation with a controlled drainage system [1]

Figure 2: Location of CD study areas in Egypt

Resutes and Discussion

In Egypt, CD was applied in rice cultivation as wet foot and other dry foot crops and saved irrigation water by 28% for rice, [3] and 15% to 20% for wheat [4]. Regarding crop yield, CD did not affect rice yield but makes an increase in other crop yields, by 15.6 % and 6% for wheat and maize, respectively [5]. CD reduced nitrate losses by a range from 32% to 73% for wheat and maize, [6] as shown in the Table.The findings in the USA indicate that the implementation of CD resulted in a reduction of nitrate losses ranging from 58% to 99% (see the Table), [7] and [8]. In the context of wheat cultivation in Denmark, CD reduced nitrate and phosphorus losses by a range of 38% to 51% and 43% to 46%, respectively [9]. The use of CD in rice cultivation in India resulted in a 17% reduction in irrigation water and a 50.4% decrease in nitrate losses [10]. CD implementation has the potential to effectively

save irrigation water, enhance water quality, and facilitate the management of water resources in alignment with (SDG 6). In addition, CD reduces irrigation times, leading to a subsequent decrease in energy usage, aligning with (SDG 7) and consequently reduces Green Houses Gas (GHG) emission and climate change impact on the environment. Furthermore, concerning (SDG2), there is a notable emphasis on the augmentation of agricultural output. CD can provide up to $20.39 of net revenue per feddan annually on a farm growing corn and soybean ۲ in equal amounts over the lifetime of the control structure (estimated at 20 years) in Ontario, Canada [11], (SDG 8). CD enhances international support for implementing effective and target capacity building in developing countries (SDG17).

Table: Impact of CD in the studied areas

Studied areas		Irrigation saving %	Nitrate losses %	Phosphorus losses %	Increase in crop yield %	References
Egypt	Nekla	28	**	**	Rice*	[3]
	El Baradei	15.6 14	** **	**	(-)Wheat 6 Maize	[5]
	West Nile Delta	15-20	**	**	Wheat**	[4]
		**	32 - 73	30 -77	Wheat-Maize**	[6]
USA	Indiana	**	58-68	*	Corn-Soybean**	[7]
	Missouri	**	99	90	Sorghum **	[8]
		**	69	*	Cereal rye**	
Europe	Denmark	**	38-51	43-46	Wheat*	[9]
Asia	India	17	50.4	**	Rice*	[10]

*No increase in crop yield

(-) Lower crop yield

**Crop yield, Nitrate and Phosphorus losses did not include

Conclusion

The present article provides a comprehensive review of the controlled drainage technique and its global implications across various nations. The results revealed that the implementation of CD practices leads to the conservation of irrigation water and a rise in crop productivity. The CD has been found to effectively decrease the amount of drainage water and minimize nutrient losses in such waters. This results in a more efficient utilization of nutrients by crops. CD aligns with the SDGs' targets 6.2, 6.3, and 6.4, which pertain to efficient water management, enhancing water quality, and optimizing water usage efficiency, respectively. Furthermore, CD aligns with SDGs' targets 2.4.1, 7.3, 8.2, and 17.9 which pertain to economic and social objectives. This article on the application of CD presents significant potential for attaining multiple SDGs. In Egypt, despite the advantages of CD over conventional drainage, CD hasn't yet been implemented on large scale; only research projects and studies has been conducted.

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Chitosan-g-polyacrylonitrile ZnO nano-composite, synthesis and characterization as new and good adsorbent for Iron from groundwater

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Keywords: Adsorption, Chitosan, composite, Polyacrylonitrile, Zinc oxide.
CWW2023 Theme: 3

ABSTRACT

The highly poisonous, non-biodegradable heavy metals present serious concern in wastewater environmental sustainability and human health. Using adsorption is an effective technology for the treatment of this kind of water. Therefore, developing efficient and cost-effective adsorbents considers a significant and an emerging topic in the field the water purification. Chitosan grafted polyacrylonitrile (Cs-g-PAN) was facially fabricated via graft polymerization using ammonium persulfate (APS) as the initiator. The simple ultrasonic technique was used for doping ZnO nanoparticles into the Cs-g-PAN matrix to prepare chitosan-grafted polyacrylonitrile/ZnO (Cs-gPAN/ZnO). For comparative study, pure ZnO and nanocomposite of PAN doped with ZnO (PAN/ZnO) were also prepared. XRD, FTIR, SEM, TEM, BET, EDS, and TGA measurements were conducted to confirm the morphological and structural properties of the prepared materials. Cs-g-PAN/ZnO possesses a specific surface area of 20.23 m^2 /g with a pore size of 31.58 nm and pore volume of 0.16 cm^3 g^{-1}. The adsorption behavior toward Fe (II) as a pollutant for groundwater was studied for the synthesized materials.

The effect of pH (4–8), contact time (5–60 min), adsorbent dose (0.01–0.3 g), and different temperature degrees (278, 288, 298, 308, and 318 K) on the removal of iron (II) has been conducted. The removal efficiency was achieved 100 % under the optimum condition, at pH = 7, contact time 30 min, adsorbate concentration 0.93 mg/ L, and adsorbent dosage 0.05 g/L at room temperature. Langmuir and Freundlich's isothermal and kinetic studies have been analyzed to determine the adsorption mechanism of Fe(II) ions on the synthesized nanomaterials. The adsorption process of Fe(II) over the surface of prepared catalysts proceeded via the Langmuir model and pseudosecond-order reaction kinetics with $R^2 > 0.99$. Suggesting the formation of Fe(II) monolayer over the adsorbent surface and the rate-limiting step is probably controlled by chemisorption through sharing the electrons between Fe^{+2} and the prepared catalyst.

The type of water intended to be studied in this research **(groundwater)**

Aim of Work

The goal of the current study was to discover a fast, affordable, and safe process for removal of iron from ground water. Where the excessive iron (II) content in drinking water can cause lifethreatening problems including, siderosis, anorexia, hypothermia, diphasic shock, metabolic acidosis, oliguria, diarrhea, heart failure, diabetes, and even death. For this reason, the World Health Organization WHO fixed the tolerance limit of Fe(II) concentration in drinking water as <0.3 mg/ L. So the authors try to present a safe and economic solution by preparing chitosan-grafted polyacrylonitrile/ZnO (Cs-gPAN/ZnO) and use it for removal of iron from ground water.

Materials Chitosan, Methanol, Ammonium persulfate, zinc acetate, Acrylonitrile and Sodium hydroxide. Twice distilled water was used as a medium for all the polymerization reactions. All reagents were used without further purification.

Methods

Preparation of Chitosan-Graft-PAN/ZnO(CS-g-PAN/ZnO) and Poly Acrylonitrile/ ZnO (PAN /ZnO) composites

1- 1 g of Cs-g-PAN has immersed in a 50 mL zinc acetate solution of 6% with a weight ratio of 1:3 Cs-g-PAN: zinc acetate. The solution was sonicated for 2 hours at 70°C.
2- PAN /ZnO composite was prepared by the same previously described method by replacing Cs-g-PAN with PAN.

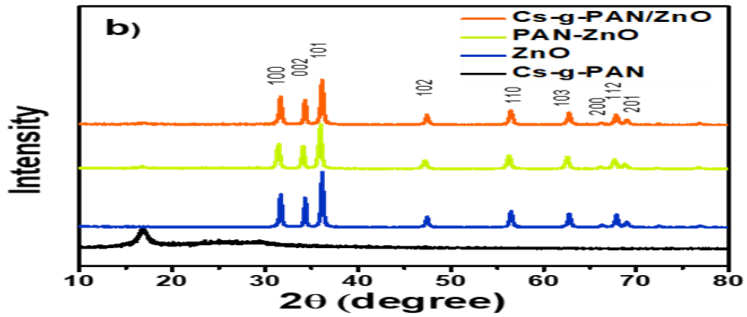
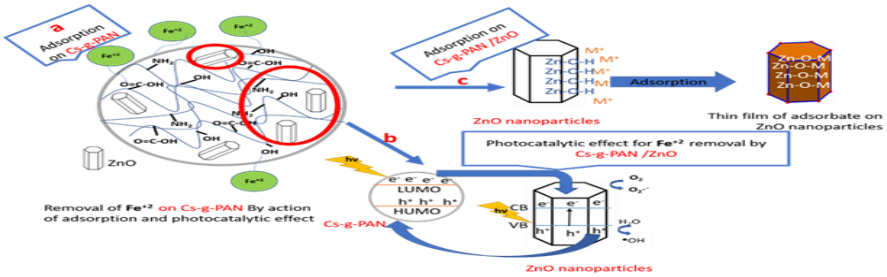


Figure 1: XRD of the prepared samples.

The diffract grams of pure chitosan sample shows the intense peak at 2θ= 17° is due to the crystal planes of PAN.The broadening of the peak at 24 is due to the amorphous nature of the polymer. The small intensity of this peak is ascribed to the grafting of PAN onto chitosan. Pure ZnO the characteristic peaks at 2θ = 31.87°, 34.55°, 36.35°, 47.59°, 56.66°, 62.89°, 66.40°, 67.89°, 69.17°, 72.59° and 77.00° .



Scheme 1: Mechanisms for removal of Fe(II) by Cs-g-PAN/ZnO

Removal mechanisms of Fe(II) depend on the contribution of three constituents in the composite, chitosan, polyacrylonitrile, and ZnO. The enhanced removal of Fe(II) under UV-illuminated conditions can be interpreted by the fact that UV exposure can lead to the scission and cleavage of the polymeric chain of the chitosan matrix, adding extra carboxyl groups within the chitosan structure. These new carboxyl groups can act as additional active sites for Fe adsorption

The presence of a negative charge on the surface creates active adsorptive sites for the attachment of positively charged heavy metal ions of Fe(II). When radiation of the light strikes ZnO nanoparticles, it causes electrons in the valence band to become excited and move into the conduction band. This results in the formation of highly active electrons in the conduction band and holes in the valance band, which leads to the generation of radicals.

Conclusions:

The prepared superior adsorbent Cs-g-PAN/ZnO was characterized using XRD, FTIR, SEM, TEM, and TGA and resulting data proved the successful grafting of polyacrylonitrile on the surface of chitosan and growth of ZnO nanoparticles on the chitosan surface using ultrasonic technique. The obtained results from the adsorption experiment demonstrated that Cs-g-PAN/ZnO showed the highest adsorption capacity toward Fe(II) compared to bare Cs-g-PAN, ZnO, and PAN-ZnO. The adsorption behaviors of Cs-g-PAN/ZnO were investigated, which confirmed that the introduction of ZnO significantly improves the adsorption capacity in a short time, over a wide pH range, using a small quantity of adsorbent. The isotherm and kinetic data for the Fe(II) adsorption onto the prepared adsorbents fit well to the Langmuir model with $R^2 > 0.99$ and pseudo-second-order reaction. Cs-g-PAN/ZnO considers an environmentally friendly promising candidate for the removal of highly toxic pollutants from aqueous media such as heavy metal Fe(II) due to its high adsorption efficiency, and low cost.

Acknowledgment

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The Use of Adsorptive Techniques and Biological Degradation for the Removal of Phenol from Wastewater

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Keywords: Activated sludge, Kaolin, Phenol, 4-Chlorophenol, Adsorption, Thermodynamic.
CWW2023 Theme: 3

ABSTRACT
The elevated toxicity of phenol compounds, even when present in low levels, causes severe contamination of soil, underground and surface waters [1]. Phenol exerts adverse and irritating effects on skin, eyes, nervous system, kidneys, liver and muscles [2]. WHO has recommended less than 1µgL-1 as the allowed concentration of phenol in drinking water [3].

Introduction
Water is the main component of life on Earth, but it is susceptible to contamination. Water pollution is as a result of contaminations from natural and anthropogenic activities. Phenol is highly toxic, chemically stable and appreciably soluble in water [4]. There are conventional directions for removing phenol from wastewaters, either physicochemical or biological.

Methods
(1) Natural, acid and base modified kaolin clays were studied for the sake of phenol and 4-chlorophenol removal from aqueous environments and their application to real ground and industrial wastewater samples as in the case of Ul HAWA textile plant, Middle Egypt [5]. The adsorbents microstructure was characterized using Scanning electron microscope (SEM), infrared spectroscopy (IR), X-ray diffraction (XRD), Thermo Gravimetric Analysis (TGA), Differential Thermal Analysis (DTA) and Surface area analysis. Adsorbent dose, solution pH, initial phenol concentration and contact time which affect the efficiency of the removal process were studied. Optimal conditions for phenolic removal were: contact time of 300 min, primary phenol solution of 25 mg/L, pH 7 and 2.5 g/L as an appropriate adsorbent dose using crude (natural), acid modified and base modified kaolin clays. The higher phenolic removal efficiencies were obtained at 5 mg/L as 90, 97, and 96.2% respectively for the adsorbents in the previously mentioned order. The adsorption capacity

of the used adsorbents in the removal of phenol and 4-chlorophenol were 7.481 & 4.195, 8.2942 & 3.211 and 8.05185 & 18.565 mg/g, respectively. The adsorption equilibrium data were fitted and analyzed with 4 isotherm models viz., Langmuir, Freundlich, Temkin and Dubinin-Radushkevich isotherm equations, as well as four adsorption kinetic models. The desorption % capacity was amounted to 96, 91.11 & 87.06 % of adsorbed phenol, respectively, for the adsorbents in the previously mentioned order using 0.1N NaOH and 10% V/V ethanol solutions as eluents at 25°C, indicating the reusability of the adsorbents.

(2) Phenol bioremediation was investigated by two bacteria (primarily cocci) Dermacoccusnishinomiyaensis strain, Kocuria Rosea strain and the one actinomycetes strain Nocardiopsislucentensis, which were obtained through isolation from samples of activated sludge from the wastewater treatment Plant (WWTP) in Beni-Suef, Egypt [6] as sole carbon and energy sources. Degradation of phenol by microbes adsorbed on natural kaolin clay was also studied in comparison with free microbes. In case of 50 mg/L as starting phenol concentration, the percentage removal using free microbes was 68%, while it has reached 98% in case of microbes adsorbed on the surface of kaolin clay after the passage of 48 h under incubation at 30°C and neutral pH at 150 rpm. Reduction of the degradation time was achieved by the use of natural kaolin clay. Also, it improved the degradation frequency by 80% at a phenol concentration of 300 mg/L; while the efficiency of degradation has reached 38% after ≈ 48h without clay addition. High concentrations of an organic pollutant are usually inhibitory for the microorganisms [7]. The adsorption process was also expressed by 4 isotherm models viz., Langmuir, Freundlich, Temkin and Dubinin-Radushkevich isotherm equations

Conclusions

(1) Natural kaolin, acid and base modified clays were applied for the removal of phenol and 4-chlorophenol from authentic and real wastewater samples. Removal efficiency is affected by pH value, dose of adsorbent, starting phenol concentration and stirring time, each of these parameters has been optimized. The maximum removal efficiency took place at neutral conditions and has a positive relation with the amount of adsorbent dose until equilibrium is reached after 300 min. Adsorbents can be regenerated and reused using 0.1 N NaOH and 10% V/V ethanol solutions at room temperature. Kaolin and its modified forms can be introduced as eco-friendly and low-cost adsorbents in water remediation implementation.

(2) Kaolin clay through biofilm formation has exerted a pronounced role in accelerating the phenol degradation process, decreasing the time of degradation and increasing the removal efficiency under high phenol concentration conditions due to its buffering effect. Clay has an essential role in aiding the microbial decomposition of pollutants. Phenol elimination efficiency is affected by pH value, temperature, initial concentration of the adsorbate and contact time, each of these parameters has been tested and optimized. Adsorption capacities were 27.04 and 39.94 mg/g in case of microbial bioremediation and microbes adsorbed on kaolin clay. The method has been applied for abstraction of phenol from real industrial wastewater sample.

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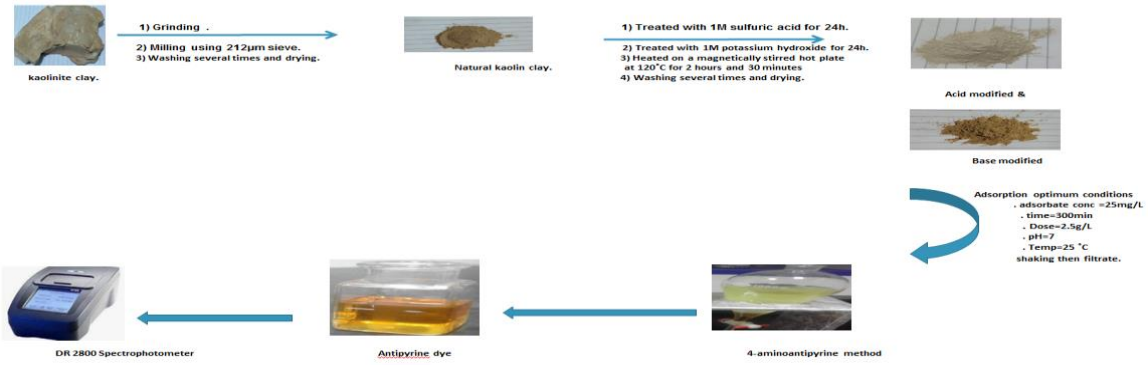

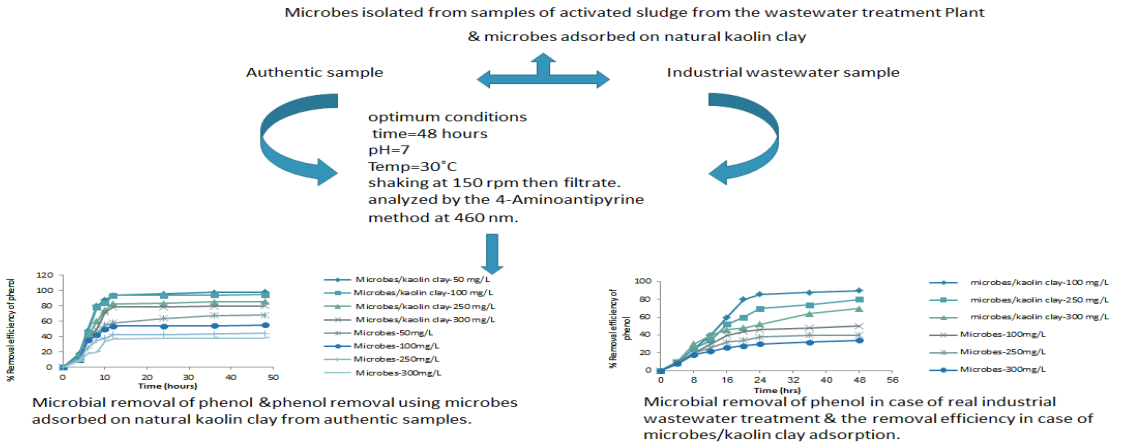

Microbial removal of phenol &phenol removal using microbes adsorbed on natural kaolin clay from authentic samples.

Microbial removal of phenol in case of real industrial wastewater treatment & the removal efficiency in case of microbes/kaolin clay adsorption.

CWW2023 – CAIRO
Cairo, 29 Oct- 2 Nov, 2023

Eco-Friendly Chitosan Adsorbents for Removal of Methylene Blue Dye from Aqueous Medium

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Keywords: Adsorbents; Caffeic; Chitosan; Gallic; Methylene Blue
CWW2023 Theme: 3

ABSTRACT

Scope and Aims

Releasing dyes through various industrial processes is a major threat to the environment. The hazardous effect of dye-polluted water refers to the possibility of dyes decomposing into carcinogenic by-products, while the dark color of some dyes affects the photosynthetic ability of marine plants [1].

To minimize the hazardous effect of dye contaminated water, many techniques have been used, such as ion exchange, chemical precipitation, solvent extraction, reverse osmosis, etc. [2] These techniques have their own drawbacks, such as low efficiency, high cost, and the specific difficult removal conditions of pH, temperature, and contact time, which result in the production of toxic sludge, which costs more in refining.

Adsorption is a promising technique characterized by its economic cost, ease of obtaining, simplicity of design, ease of use, selectivity for different concentrations of pollutants, and easy regeneration [3].

The recent study introduced new eco-friendly adsorbents based on two safe, widespread natural components (chitosan and phenolic acids). The cheapness, ease of synthesis, and pH stability of resins, in addition to high applicability and removal efficiency toward Methylene Blue dye, as a model of cationic pollutants.

Methodology and Implementation

Chitosan adsorbents were synthesized by grafting phenolic acids (gallic acid (3, 4, 5-trihydroxy benzoic acid), and/or caffeic acid (3, 4-dihydroxycinnamic acid) on chitosan to produce RI and RII. The synthesis was carried out in two steps (Scheme 1). In the first step, the phenolic acid was reacted with thionyl chloride ($SOCl_2$) to form acid chloride. In the second step, the acid chloride was reacting with chitosan to form an amide bond between chitosan and phenolic acid. The morphology and structure of synthesized adsorbents were confirmed by physical and chemical tools such as FTIR, SEM, EDX, XRD elemental analysis, TGA, water regain.

The new resins were evaluated as methylene blue dye adsorbents as a model of organic pollution in water. Factors affecting the adsorption process, such as time, temperature, pH,

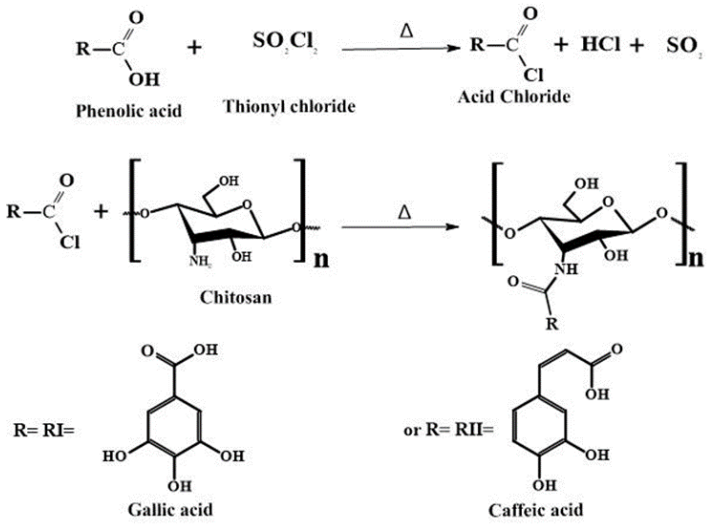
and adsorbent dose, were studied. Furthermore, the adsorption data were analyzed using thermodynamic kinetics and equilibrium isotherms in order to understand the nature and mechanism of dye adsorption. Furthermore, the ability of resins regeneration had been studied by using hydrochloric acid eluent solutions.

Key Results

Grafting phenolic acids onto chitosan is a promising technique for chitosan modification. The new modified chitosan is characterized by higher stability in acidic media, bigger surface area, and larger number of active hydroxyl groups than parent chitosan.

The new adsorbents showed efficient removal of MB dye pollution from the aqueous medium. The maximum adsorption capacity amounted to 130 and 112.4 mg/g, with removal efficiency reaching 72% and 61.4% for RI and RII, respectively, at pH 8 and an initial MB concentration of 180 mg/L. Both adsorbents showed an exothermic spontaneous chemisorption process.

The prepared adsorbents showed good re-use ability by using 0.5 M hydrochloric acid eluent, which lasted over three cycles.



Scheme 1: Synthesis of chitosan adsorbents RI and RII

Table1: Comparison of adsorption capacities of different chitosan biosorbents toward MB dye

Adsorbent	**C_0 (mg/L)**	**q_e (mg/g)**	**pH**	**Ref.**
Graphene oxide/chitosan	10	7.5٣	5	[4]
Chitosan/cellulose nanofibrils composite	200	91.44	2	[5]
Chitosan/κ-carrageenan/acid-activated bentonite	20	18.80	٤	[6]
RI	180	130	8	Current work
RII	180	112.4	8	Current work

Conclusions

Grafting phenolic acids onto chitosan is an efficient method of chitosan modification. The ease of synthesis, pH stability of resins, high MB removal efficiency compared to parent chitosan and other modified chitosan (Table 1), and reuse ability give the new chitosan biosorbents high priority over other modified chitosans. In addition, the new resins can be further applied to cationic organic and inorganic water pollution removal with the aim of expanding their use on a large scale in the treatment of various cationic water pollutants.

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Isolation and Identification of Low-Density Polyethylene (LDPE) Biodegrading Bacteria from The Mediterranean Sea.

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Keywords: Bacteria, Biodegradation, Climate, LDPE, Mediterranean, Plastic.
CWW2023 Theme: 3

ABSTRACT

The Mediterranean Sea is the biggest and deepest semi-enclosed Sea in the world [1], containing only 1% of the world's waters and 7% of global microplastics [2], with 730 tons of plastic litter produced daily, being a hotspot for microplastic pollution [3]. However, the Eastern Mediterranean basin is considered the most polluted area [4], with Alexandria, Egypt, being a major contributor to a substantial amount of plastic litter with an annual input of 2209 tons, approximately 2.2%. Through this research, Abu-Qir Bay, Alexandria, Egypt has served as the area of interest as it has been recognized as a major plastic pollution hotspot and a close-source region of restricted sea circulation [5], with LDPE being particularly a noticeable source of plastic pollution [6]

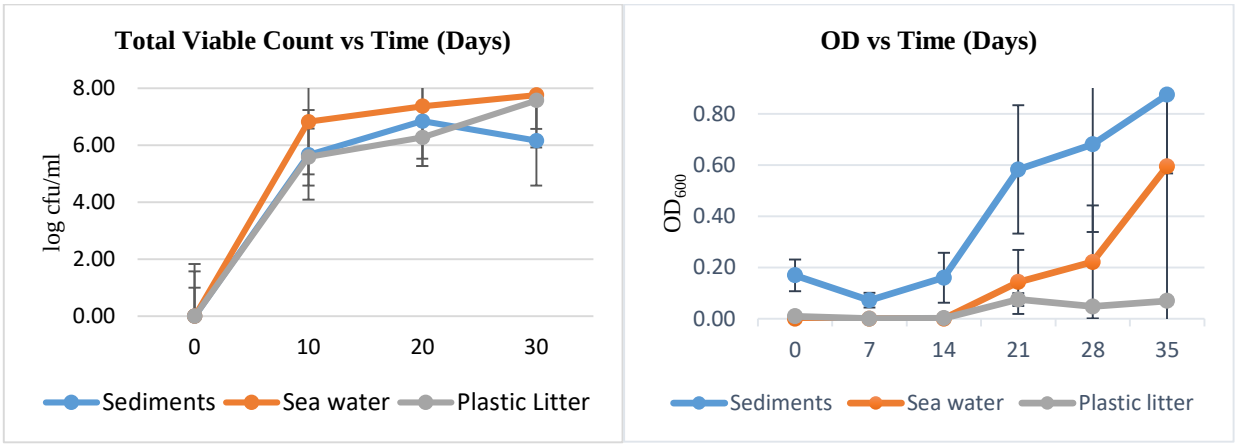
The aim of this research is to isolate and identify LDPE biodegrading bacteria and study their degrading efficiency by collecting three different samples of plastic waste litter, sediments, and seawater along the coast of Abu-Qir, Alexandria, Egypt. Sediments and plastic litter were independently collected into sterilized autoclavable Ziploc bags, while seawater was collected in autoclavable glass bottles and stored at 4℃ for further usage and processing. Afterward, enrichment of three different samples were processed using LDPE sheets.

LDPE sheets with (3cm x 3cm) dimensions labelled as (LDPE 4) obtained from local market, Cairo, Egypt were used as sole carbon source in sample's enrichment along with mineral salt medium to acclimatize the bacteria and get only the biodegrading ones. The LDPE films were weighed at 300 mg/100 ml concentration, added to the enrichment medium, and then incubated in a rotary shaker at 30 °C (150 rpm), and the total enrichment was left for 35 days [7]. To ensure the continuity of the experiment, two different approaches were used to assess microbial colonization over LDPE, either by measuring the microbial cell growth by the optical density [8] and total viable count [9] or by weighting the bacterial biomass [10]. Further, the pH of each bacterial culture was measured to validate any metabolic activity of the microbial isolates in a supplemented medium [11]. All measurements were done at regular intervals. Moreover, LDPE sheets dry weight % was taken into consideration to

assess plastics biodegradation using the following formula: % Biodegradation = (Initial weight - Final weight) / Initial weight) x 100 [12]. All experiments were carried out in triplicates, along with two negative control groups: one with no microorganism and the other with no LDPE film [13].

Figure 1.A. shows the total viable count (TVC) of three different bacterial consortiums from three different samples: Mediterranean sediments, sea water, and biomass colonizing plastic litter. The enrichment culture containing LDPE as a sole carbon source lasted for 35 days; TVC was measured at equal intervals of 10 days, showing TVC of 7.76, 7.57, and 6.16 log cfu/ml, sea water, biomass colonizing plastic litter, and sediments at day 30, respectively.

Figure 2.A. shows the optical density at 600_{nm} (OD) of the same bacterial consortium with an interval of 7 days. Sediments at day 35 showed the highest OD of 0.88 due to the sediment's contents that turbid the medium, while sea water showed an OD of 0.60 that mostly correlates with its TVC. Despite of the high TVC of biomass colonizing plastic litter it showed the lowest OD of 0.07 due to plastic attachment to LDPE.



(A) **(B)**

Figure 1. (A) Total viable count vs time in days. (B) Optical density vs time in days.
*** The mean data of each sample triplicate was used in preparation of this figure**

A simple and quick way to measure the biodegradation of polymers is by determining weight loss. Microorganisms that grow within the polymer lead to an increase in weight due to accumulation, whereas a loss of polymer integrity leads to weight loss. After completion of 35 days' plastic sheets were treated with Sodium Dodecyl Sulfate (SDS) to remove adhered cells to the film prior to weighting, however some cells remain attached resulting in total gain of film weight as shown in sediments in (Figure 2) with overall sum of means increase of 45.1 mg instead of reduction in overall weight loss as in sea water sample with value of 44.8, and a no change in biomass colonizing plastic litter sample with LDPE weight of 45 mg.

In this study, three different samples were tested for their ability to biodegrade LDPE films across 35 days, several approaches were used to test the biodegradation efficiency. Mentioned above a snippet of data that came out, showing sea water with a total loss in LDPE film with 0.44%, that was further screened to obtain the most active isolate among the consortium to be further studied with other biodegradation assay techniques as FTIR, SEM, and GC-MS.

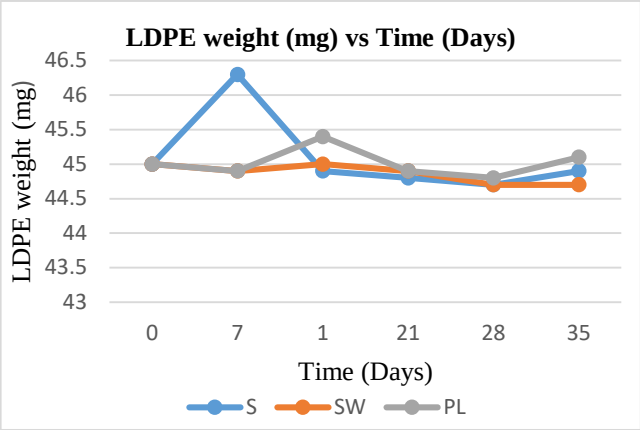


Figure 2. LDPE weight in milligram (mg) vs Time in (Days).

Acknowledgment

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Assessing the Viability of in-pond Raceway Systems in Egypt: a Case Study

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Keywords: Aquaculture, Energy conservation, Food security, IPRS, Sustainability, Water scarcity
CWW2023 Theme: 3

ABSTRACT

The rising food shortage issues in Egypt, as indicated by the Hunger Index 2022, have underscored the urgent need to address challenges related to food security, quality, and affordability. With approximately 85 million people suffering from malnutrition, the focus has shifted towards enhancing livestock and fish production to fill the growing demand gap. Fish meat, being relatively affordable, has been recognized as a suitable alternative. While Egypt has made significant strides in fish production, the consumption still exceeds local production, necessitating the exploration of innovative and sustainable aquaculture practices [1].

The water footprint associated with aquaculture systems is a significant concern, encompassing waste management, sustainability, and water quality maintenance. Conventional systems, such as traditional pond systems, have high water consumption and negatively impact water quality. Water exchange is necessary to maintain quality and prevent eutrophication, accumulation of harmful substances, and ecosystem disruption. Traditional aquaculture systems also result in the loss of up to 3.7 times more nutrients per ton of fish compared to the other alternatives [2].

To address these issues, the In-Pond Raceway System (IPRS) combines features from raceway, cage culture, and recirculating aquaculture systems. IPRS improves water usage efficiency and reduces environmental impact by incorporating recirculation components. It significantly reduces water consumption, with water savings of up to 70% compared to traditional pond-based systems. The system's recirculation capability removes excess nutrients and waste, improving water quality and reducing pollution risks, benefitting the fish population.

Despite its potential benefits, IPRS adoption in Egypt lags behind countries like China, primarily due to concerns about water usage and feasibility. This study aims to assess IPRS comprehensively, propose design modifications, and promote its widespread

implementation in the Egyptian aquaculture sector. Our specific objectives include assessing technical, and environmental aspects, optimizing IPRS design, maintaining water quality and oxygen levels, and reducing energy consumption.

An IPRS at the WorldFish Center in Abbasa, El-Sharqia Governorate, Egypt, was selected as a case study. Field data were collected for the Abbasa IPRS in late 2022 and early 2023. Water depth and velocity were sampled using an Acoustic Doppler Profiler (ADP). Dissolved oxygen (DO), temperature, and total dissolved solids (TDS) were measured in situ. Water samples were collected according to ISO 5667-3, Water Quality Sampling Manual for the Aquatic Environment, and EPA guidelines. Lab analysis was conducted according to the EPA guidelines for measuring the concentrations of ammonia, nitrate, nitrite, biological oxygen demand (BOD), and chemical oxygen demand (COD). The Deflt-3D Flow and Water Quality model was used to simulate the existing baseline conditions and optimize the water flow pattern and operational settings.

ADP data showed that the white water unit (WWU) at the upstream end of the raceways and a paddle unit installed at the opposite corner of the pond induced a clockwise circulation with depth average flow velocities of 0.021 to 0.016 m/s in the raceways and 0.022 to 0.090 m/s in the pond outside the raceways (Figure 1). Regarding the water consumption of the system, it is estimated to be about 2000 m^3 per ton of fish produced.

Collected water quality data shown in Table 1 indicates that the pond was oversaturated with DO; TDS, nitrate, nitrite, and BOD were within the limits; COD, ammonia, and phosphate exceeded the limits for fish ponds [3]. The high DO concentration was due to excessive aeration caused by continuous operation of the WWU. The oxygen loading due to aeration was estimated to be 235 kg/day. Respiration of 6000 kg of adult fish in the 3 raceways amounted to about 11 kg/day. Nutrient loading was estimated from literature about feces production over different ages of Nile Tilapia [4, 5, 6]. Estimated loading amounted to 14.9 kg/day of NH_4, 9.1 kg/day of NO_3, 6.59 kg/day of PO_4, and 120 kg/day of CBOD. The removal efficiency of the system ranged between 60 and 70%.

Table 1. Measured concentrations (ppm) of water quality constituents at different points within the pond. Measurements are from the first field trip conducted in November 2022.

Parameter	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Limits
BOD	-	14.8	7.1	12	-	9.8	< 50
COD	22	22	14	59	33	52	< 25
Ammonia	0.26	-	0.28	0.16	0.13	0.03	< 0.05
Nitrate	0.55	-	0.74	0.68	0.71	0.18	< 3
Nitrite	0.12	-	0.12	0.13	0.12	0.08	< 4
Phosphate	0.81	-	0.79	0.8	0.8	0.88	< 0.06
TDS	242	242	242	242	242	242	< 348
DO	8.47	-	8.85	8.88	8.86	8.86	> 5

Using the Delft-3D model, several scenarios were simulated to examine the effect of the baffle length, the baffle angle, and the presence of the paddle on the flow pattern. Simulation results showed that the existing baffle angle and length are optimum, the paddle has a limited effect on the flow circulation, and the major contributor is the WWU. The power consumption effect on the water quality was investigated up to 25% reduction and it showed no negative effect on the water quality.

In conclusion, the measured average velocities in the pond show unnecessary circulation around the paddle. Therefore, it is recommended to remove the paddle and rely on WWUs. Moreover, the power consumption can be reduced by 25% without affecting the water quality while additional research is required for further power reduction. As the DO concentration in the pond is supersaturated, it is recommended to shut down the aerators to examine the depletion rate and the minimum oxygen level that the pond may reach. To lower the elevated levels of COD, ammonia, and phosphate, the fish density in the raceways may be reduced. Alternatively, further investigation of the configuration of the quiescent zone downstream of the raceways may help increase removal efficiency and lower elevated concentrations.

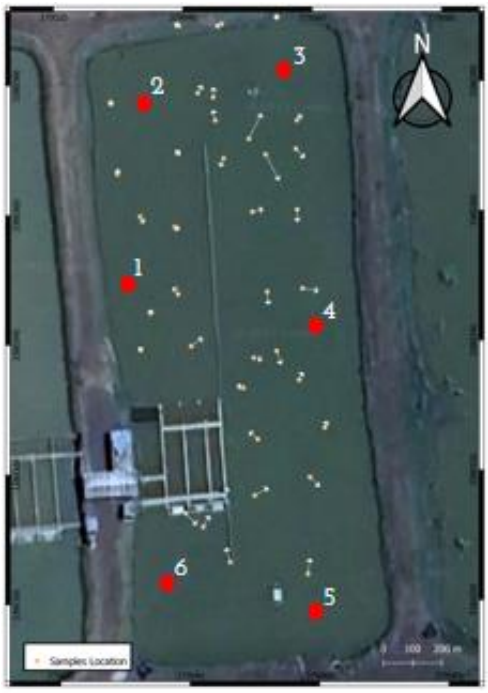

Figure 1. Observed horizontal flow velocities inside the pond. (white arrows). Red dots denote water quality sampling points.

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Evaluating the Use of the Chemically and Biologically Treated El-Rahawy Drain Wastewater in the Agriculture of Corn Crop

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Keywords: Treatment, El-Rahawy Drain, Corn, Zeolite, and Algae.
CWW2023 Theme: 3

ABSTRACT

As a consequence of fresh water shortage, non-conventional water resources were becoming increasingly demandable in arid and semi-arid regions due to the increase in population and urbanization. In Egypt, the reuse of drainage water provides a demanding supplement to the irrigation water. This research aims at presenting natural treatment process for drainage wastewater to be reused in irrigation to increase water resources and water quality control. Two biological and chemical wastewater treatment techniques (Algae and Zeolite), under different conditions, were applied to allow the reuse of wastewater to be used in the agriculture of an economically important crop which is corn, and comparing the production and the chemical components of the crop with the one irrigated by fresh Nile water. Water samples used for irrigation were obtained from (Nile River and untreated wastewater collected from El-Rahawy drain, Giza, Egypt). Corn seeds (TWC) were obtained from Field Crops Research Institute, Agricultural Research Center, Giza, Egypt. Natural Chlorella vulgaris algae were obtained from the National Research Center, Giza, Egypt and, using commercial natural zeolite.

The field experiments of this research paper were carried out in experimental region for central laboratory that is affiliated to the National Water Research Center, El-Kanater El-Khaireya, that is adjacent to the Nile River. The land was divided into four parts according to the type of treatment applied:

- Irrigated with fresh Nile water (T1).
- Irrigation with Drainage wastewater (T2).
- Biological treatment: irrigation with wastewater treated by algae; Chlorella vulgaris (T3)
- Biological and chemical treatment: wastewater treated by algae (Chlorella vulgaris) and zeolite was mixed to the soil (T4).

The four treatments were employed in order to study the effect of reuse of wastewater on vegetative growth, dry seeds and, leaves yield components, and soil chemical - physical properties as well as soil enzyme activity.

Chemical and physical parameters for Soil and water samples as (pH), electrical conductivity (EC), total dissolved solids (TDS), Biological oxygen demand (BOD), Chemical oxygen demand (COD), anions, cations, and heavy metals were measured. The total soluble nitrogen

(N), phosphorus (P), potassium (K), heavy metals, Protein, and carbohydrate were determined for plant samples. Sampling and preservation procedures were carried out according to Standard Method for Examination of Water and Wastewater (APHA, 2017).

The biological treatment was done by putting El-Rahawy wastewater in glass tanks (with 50, 30, and 50 cm length, width, and height respectively) and adding algae. the tanks are subjected to aeration and lightening systems for 48 hours to allow to the algae to grow normally. While, chemical treatment was carried out by mixing Zeolite to the soil. Soil enzymes activities as Dehydrogenase activity, phosphatase enzyme activity, and nitrogenase activity were determined and, calculated based on oven-dry (105°C) weight of soil. Statistical calculations were performed using the SPSS v.20.

Table1. Chemical analysis of seeds and leaves for different treatments

	Seeds				
Treatment	N (%)	P (%)	K (%)	Protein (%)	Carbohydrate (%)
T1	0.82c	0.17b	2.60b	5.13d	72.36b
T2	0.99b	0.21b	2.87a	6.19b	73.17a
T3	0.96b	0.16b	1.03c	5.98c	73.31a
T4	1.82a	0.27a	0.94c	11.39a	73.12a
LSD 0.05	0.043	0.0518	0.1548	0.06173	0.1821
	Leaves				
Treatment	N (%)	P (%)	K (%)	Protein (%)	Carbohydrate (%)
T1	0.64d	0.1397d	2.23ab	3.99d	10.24d
T2	0.98b	0.1821b	2.56a	6.13b	11.68b
T3	0.90c	0.1691c	2.49b	5.63c	11.03c
T4	1.31a	0.3089a	2.55a	8.16a	15.2a
LSD 0.05	0.046	0.00311	0.8665	0.1595	0.55

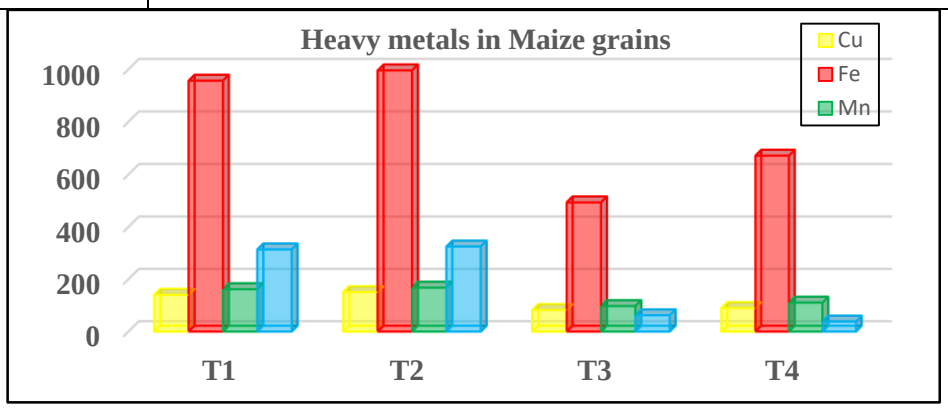

Figure 1: Heavy metals accumulation in maize grains

Data of Tables 1 showed the influence of different treatments and their interactions on grain, and leaves quality traits i.e. N, P, K, carbohydrates, protein (%). Additive of zeolite and algae treatment caused marked increase in plant quality parameters, where corn plants grown

on untreated soil or water recorded the lowest values than that with soil addition of zeolite. This result is in accordance with those of (Khalifa, *et al.* 2019, El-Sherpiny *et al*. 2020). The heavy metal contents in corn seeds (edible part) are indicated in Figure 1). The accumulation of Cu, Fe, Mn, and Zn is greater in the case of wastewater-irrigated plants than controls. The lowest accumulation of heavy metals was detected under Chlorella vulgaris treatment and soil mixed by zeolite. The different treatments of soil were affected the activity of soil enzymes. Higher enzyme activities were noticed in the soil irrigated with treated wastewaters (Figure 2). The dehydrogenase activity ranged from (43.3 to 144.9 µg TPF formed g^{-1} hr^{-1}). The highest dehydrogenase activity was observed in T4 in the soil followed by T3. The activity of phosphatase in the soil ranged from 30.29 to 53.79 µg PNP g^{-1} hr^{-1} under different treatments. The nitrogenase activity ranged from 34.70 to 82.40 (N moles C2H4/g/day). The increased enzyme activity occurs due to addition of organic material and nutrients to the amended soils with zeolite through wastewater which serves as a source of energy for microbes and enzymes (Shivakumara *et al*, 2019).

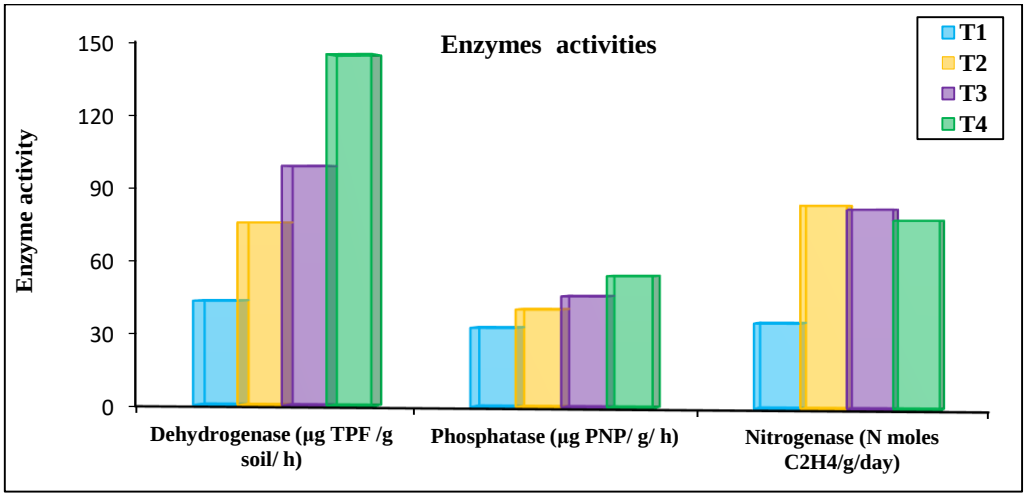

Figure 2: The activities of dehydrogenase, phosphatase and nitrogenase for all treatments

Conclusion

Irrigation of corn plants using untreated wastewater significantly increased the contents of Yield parameters, compared with control, also Cu, Fe, Mn, and Zn exhibit the highest rate of plant uptake in seeds (edible part). On the other hand, application of Chlorella vulgaris treatment, and soil mixed zeolite alleviated the adverse effects of wastewater irrigation via decreasing the oxidative damage. Addition of zeolite affects soil chemistry. In terms of N, P and, K uptake in plant tissues by improving N, P and K uptake efficiency in comparison with control treatment Further protection under irrigation with wastewater was achieved by applying our treatments, which reduce the accumulation of Cu, Fe, Mn, and Zn in seeds (edible part) of maize plants. This study clearly emphasis the goodness of zeolite addition to the soil which irrigated with treated wastewater with Chlorella vulgaris in order to nutrient management practices and its influence on enzymes and microbial activity in the soil. Finally, Chlorella vulgaris and natural zeolite being economically and environmentally friendly which can be recommended for farmers to use in their fields to alleviate the harmful effects of wastewater on plants.

Acknowledgment:
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Cost Model for Upgrading Electromechanical Components in Existing Hydropower Plants

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Keywords: Hydropower, Re-powering, upgrading options cost, Upgrading topologies and Up-powering
CWW2023 Theme: 3

ABSTRACT

The gap between electricity demand and supply is globally increasing. In addition to that, the traditional sources of energy –fossil fuels – are extremely consumed lately as well as their cost is rising each day. As a consequence, increasing the supply is a global obligation to balance the shortage in the demand-supply equation. Recently, there is an increasing focus on renewable energy usage over traditional sources of energy; including hydropower energy. This study focuses on hydropower energy generation since hydropower supplies about 17% of the world's total electricity and over 73% of all renewable electricity [1].

This, in turn, suggests either upgrading the generated hydropower from existing plants, repowering or up-powering options, or constructing new ones. The success of new hydropower projects is decreasing due to social opposition. Hence, upgrading existing installations –with minor modifications– might be the only alternative to extract flexibility from hydropower. Decision makers don't have the necessary tools that help assess the cost associated with each option.

Repowering is where equipment is replaced on a "like for like" basis or either refurbished. Repowering typically includes generator refurbishment, turbine refurbishment and Unit refurbishment. While up-powering involves increasing capacity and efficiencies. The up-powering typically includes replacing an old turbine with a new one, adding a new unit consisting of a new turbine and changing the system to be pumped-hydro, as shown in Figure 3 [2].

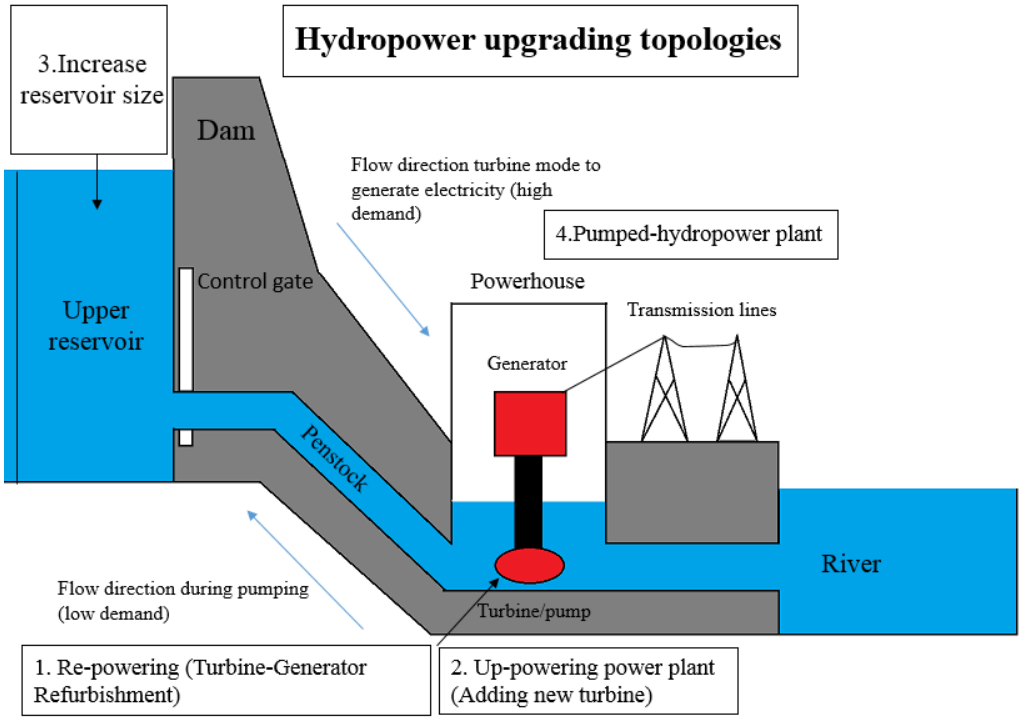

Figure 1: Hydropower upgrading topologies

This study compares the cost between repowering and the up-powering of an existing facility. For this sake, a set of samples was collected with the characteristics and the associated costs of different implemented projects.

The dataset was first used to validate the Norwegian model for cost estimation for the three types of turbines. The validation results indicated that the tool seemed to be doing a great job resembling the actual costs for Francis and Pelton-based turbine systems, with a less accurate model when Kaplan was used. The average cost differences for Francis, Pelton and Kaplan are 5%, -3% and 49%, respectively.

The next stage involved utilizing regression models as unit-addition cost equations for each turbine type. All the equations are a function of Unit Power (P), Head (H) and Unit Discharge (Q). 80% of the number of samples in each dataset were used for calibrating the model, while 20% were left for validation of model resulting equations. The generated equations have very high adjusted Coefficients of determinations; 0.99 for Francis, 0.92 for Kaplan and 0.95 for Pelton. Parametric analysis has been done according to the following equations, to find that the most affecting parameter is the unit flow and the least affecting parameter is the unit head.

$$C = e^{-2.08}P - e^{-9.02}\boldsymbol{P}^2 + e^{-4.33}H - e^{-10.64}\boldsymbol{H}^2 + e^{-2.41}Q - e^{-11.12}\,\boldsymbol{Q}^2 + 3.402 \qquad \text{Equation 1 (Francis)}$$

$$C = e^{-3.56}P + e^{-5.44}H + 1.1Q - 5.04 \qquad \text{Equation 2 (Kaplan)}$$

$$C = e^{-2.49}P - e^{-3.76}H + e^{-4}Q + 5.81 \qquad \text{Equation 3 (Pelton)}$$

The following table provides a summary of the validation results for the Regression models.

Table 1: Summary of calibration and validation results for the Regression models

Turbine type	Errors range (calibration samples)	Error average value (calibration samples)	Errors range (validation samples)	Error average value (validation samples)
Francis	-14%, 24%	1%	-10%, 26%	6%
Pelton	-40% , 9%	-3%	-13% , 34%	6%
Kaplan	-18%, 8%	-5%	-3%, 10%	4%

Finally, a program has been developed to calculate various upgrading options depending on the two used models, the Norwegian water resources and Energy Directorate, and the other is the regression model based on real case studies. A cost estimation tool for various upgrading options has been developed to calculate the cost of each upgrading technique such as unit (turbine and generator) addition (with/without penstock), unit refurbishment, replacing an old turbine with a new one, and changing the system to be pumped-hydro.

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Tracing TOC concentration and $SUVA_{254}$ in surface water, treated water and wasted aluminum sludge.

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Keywords: Greate Cairo WTPs, Ismailia Canal, Nile River, Organic load, Sharkawia Canal, $SUVA_{254}$, TOC.
CWW2023 Theme: 3

ABSTRACT

Safe water production is the world's primary concern; however, organic pollution is a continuous threat to it. Egypt depends primarily on the Nile River to supply potable water. Organic pollution could be of natural or anthropogenic sources. Using freshwater with elevated organic load in drinking water production may increase the risk of the formation of disinfection byproducts (DBPs). Coagulants are used through effective conventional treatment to reduce turbidity and organic matter. Disinfection using chlorine generates harmful byproducts. Many research articles and the world health organization reported the potential risk from cancer consuming water contains DBPs concentrations more than the limits. The ability of organic matter to produce DBPs is resolute by its complexity. The absorbance of ultraviolet rays at wavelength λ 254 nm was reported as an indicator for the complexity of organic matter revealing its readiness to form DBPs. Chlorine and organic matter concentration and retention time are the major parameters control the DBPs formation.

This study aims to evaluate the quality of raw water and the effect of conventional treatment in eight Water Treatment Plants (WTPs) in Cairo. Raw, tap water and sludge TOC and UVA_{254} was measured. Raw, sludge and tap waters $SUVA_{254}$ was calculated as the result from dividing UVA_{254} by Dissolved Organic Matter (DOM) to determine the WTP's efficiencies to reduce DBPs formation probability and the complexity of the organic matter in wasted sludge.

The treatment process nearly has a constant reduction in raw water TOC concentration. Moreover, $SUVA_{254}$ is still showing the same response in Mostorod tap water, which confirms that the operational conditions, chemical dosing, treatment design could not change the nature of organic compounds detected in Mostorod raw water. In other words, the industrial effluents should not be disposed of in the Ismailia canal, especially near and upstream to Mostorod WTP intake and the Egyptian regulations for protecting WTPs intakes should be applied. Figures 1 and 2 are endorsing the effect of the treatment process, which is reducing the TOC concentrations from raw to tap water, as shown. $SUVA_{254}$ values decreased by the treatment in all the studied WTPs except Mostorod WTPs. So, conventional treatment reduces TOC concentration found naturally in raw waters and high molecular weight aromatic organic compounds with little concentrations. That is because of chlorine as a remarkable oxidant oxidizes organic compounds and chlorinates it, forming less complicated organic compounds. Coagulation also has a notable effect on the structure and

concentration of organic compounds released and detected in tap water through several mechanisms include adsorption, absorption, and electrostatic attraction. The reduction in organic matter and aromaticity in tap water is owed to the highly positive charge produced by hydrolyzed aluminum hydroxide which neutralizes the majority of organic compound that is negatively charged due to the presence of negatively charged functional groups [1].

TOC detected in Embaba and Rod El-Farag sludge samples show the maximum values. Embaba WTP is the maximum due to the operational conditions were not optimal during the sampling time, and the rate of sludge withdrawal and disposal was not efficient that led to excessive accumulation of organic compounds in the sludge. These observations and remarks are compatible with many articles include [2]; [3]. On the other hand, Rod El-Farag WTP design is using the slurry as a coagulant aid to enhance the treatment process. The continuous slurry circulation process accumulates organics and other pollutants in it, which infer that applying the SOPs in Embaba WTP could improve the quality of sludge regarding the organic matter. Unfortunately, the quality of the wasted sludge from Rod El-Farag WTP could not be improved as it is one of the design drawbacks of the sludge reuse [4].

The previous findings tell that not only the amount of TOC is of profound influence on the water treatment plants but also the extent of its molecular weight and aromaticity is an immensely powerful factor. That is clear from the results of Mostorod WTPs if compared to other WTPs. The Nile River, Ismailia and El-Sharkawia canals exhibit stable readings of TOC with no extreme increase. The TOC values show an increasing gradient from south to north and from summer to winter. Tap water and sludge samples showed fluctuated values depending on the efficiency of each WTPs and operational conditions. A remarkable increase in organic compounds was found in Mostorod WTP in raw and tap water due to industrial spills. The treatment process in Mostorod WTP reduced the $SUVA_{254}$ but it still more than other WTPs which means it still poses a threat to the consumers. Finally, more attention should be given toward the illegal industrial spills to fresh surface water.

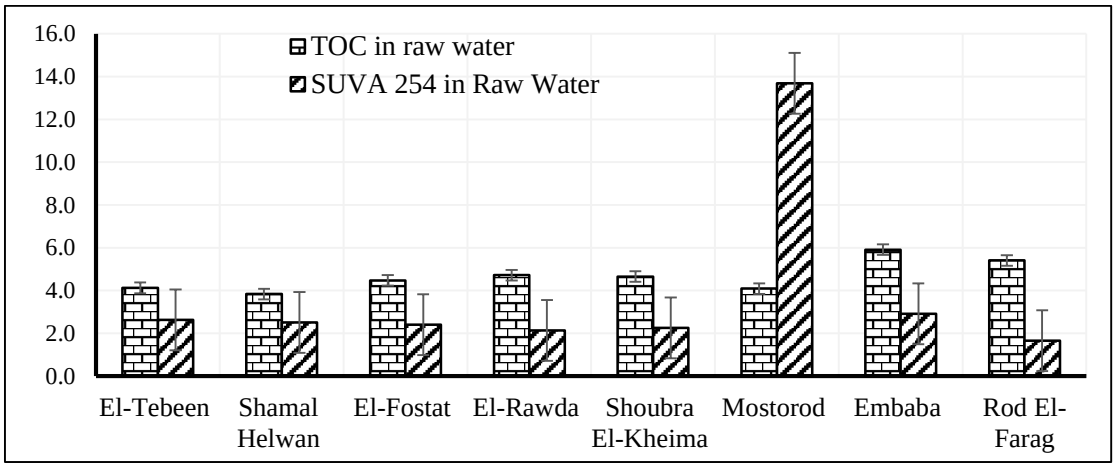

Figure 1: TOC (mg/l) and $SUVA_{254}$ (L/mg. m) in raw water

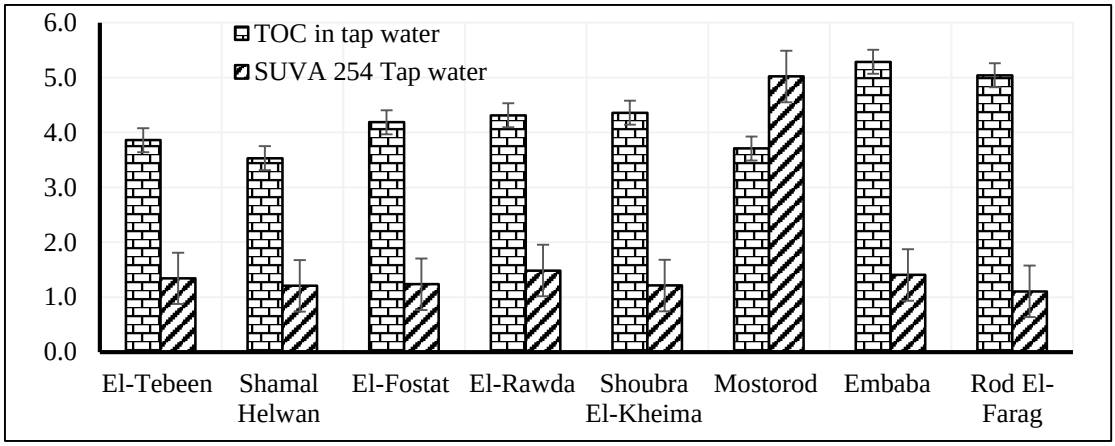

Figure 2: TOC (mg/l) and $SUVA_{254}$ (L/mg. m) in tap water

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A Comparison Between Commercial and Natural Activated Carbon Nano Sheets for Wastewater Treatment

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Keywords: Adsorbents, Carbon, Dyes, Wastes, Natural, Pollutants, Treatment
CWW2023 Theme: 3

ABSTRACT

Water pollution caused by industrial dyes has a significant environmental concern, particularly in developing countries where lax regulations and inadequate wastewater treatment facilities exacerbate the issue. Industrial activities generate wastewater containing harmful chemicals, including dyes, acids, alkalis, and heavy metals. The discharge of these pollutants into water bodies can cause serious ecological and health problems, impacting aquatic life and human health. To address this issue, many countries are considering implementing wastewater treatment plants that use physical, biological, and chemical processes to purify wastewater. However, developing effective and affordable wastewater treatment technologies remains a challenge. Adsorbent materials are considered as a promising alternative for pollutant removal from wastewater. This study presents a novel technique for producing an effective adsorbent sheet for wastewater treatment. The researchers used cellulose sugarcane bagasse fiber as a scaffold combined with activated carbon-prepared adsorbents and natural chitosan nanoparticles to create the sheets, which were studied for their ability to remove dyes.

Materials and Methods:

Extracted cellulose from bagasse pulp is used as the support layer for the adsorbent sheets where the prepared activated carbon and natural chitosan are loaded. The cellulose support and the activated carbon are prepared individually and then added to each other by blending technique. The first step in the preparation of the sheet is the soaking process. The bagasse is soaked in a 15% Na2CO3 solution for 30 minutes at 100°C. The pulp sample, weighing 30 g, is prepared for the soaking process. The Na_2CO_3 solution is prepared by dissolving 15 g of Na_2CO_3 in 100 mL of water. After the soaking process, the pulp is cooked with a solution of 6% mass concentration of NaOH in an 8:1 mass ratio. The mass of the cooking solution is calculated to be 240 g from the previous mass ratio. The cooking solution is added to the soaking product and heated at 170°C for 1 hour. Additives such as glycerol and starch can be added to the cooking mixture to improve the flexibility and water resistance of the membrane sheet . Chitosan nanoparticles derived from shrimp and activated carbon from

bagasse can also be added as additives to enhance the properties of the membrane sheet. The chitosan nanoparticles are prepared by dissolving chitosan powder in an acetic acid solution and then adding it to a sodium tripolyphosphate solution under stirring. The resulting chitosan nanoparticles are added to the cooking mixture and stirred for a few minutes to ensure homogeneous distribution. The activated carbon is added to the cooking mixture during the heating process. FT-IR ,XRD and SEM analyses are used to characterize the samples. The prepared sheets are able to retain the pollutants, with the best removal efficiency of 99.4% for dyes adsorption onto the bio-composite mixed sheet Finally, the membrane rolled by two methods: using a roller sheet machine or manually. (Brunauer-Emmett-Teller) BET test is performed on the fabricated membranes for surface analysis.

Results and Discussion:

Morphology analysis

(Brunauer-Emmett-Teller) BET test.

The fabricated membrane is analyzed using the BET method, which indicates a surface area of 30.5m2/g, demonstrating a relatively high value. The membrane exhibits a considerable capability for absorbing a large quantity of dye particles [3,4]. Nevertheless, the mean particle residue and overall pore volume measure 44.6, suggesting that the membrane's efficacy in catching and holding particles may be rather low.

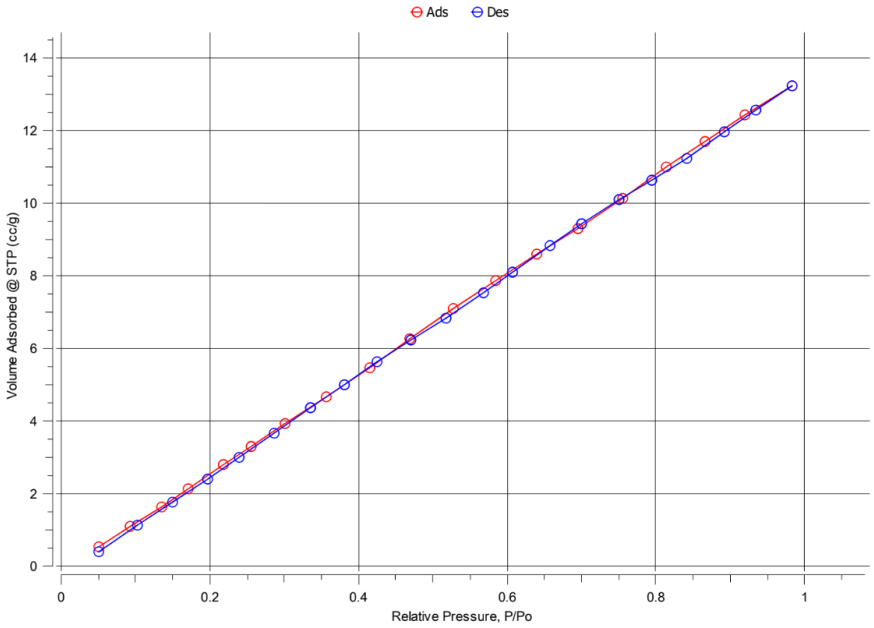

Figure 1: BET of the fabricated natural cellulose membrane.

Scanning electron microscope (SEM) analysis for fabricated sheet

Figure 2 represents the SEM analysis of the manufactured sheet; it provides information about the micro surface morphology and structure of the membrane. The results indicated that the composite membrane exhibited leaf-like and ridge-and-valley surface structures, which may indicate surface irregularities or protrusions. These structures resembling leaves can contribute to the total surface area and potentially improve the absorption properties.

The ridge-and-valley pattern indicates the presence of alternating ridges and valleys on the surface of the sheet. This pattern has the potential to increase surface area and facilitate better interaction with pollutants as well as enhanced mechanical properties.

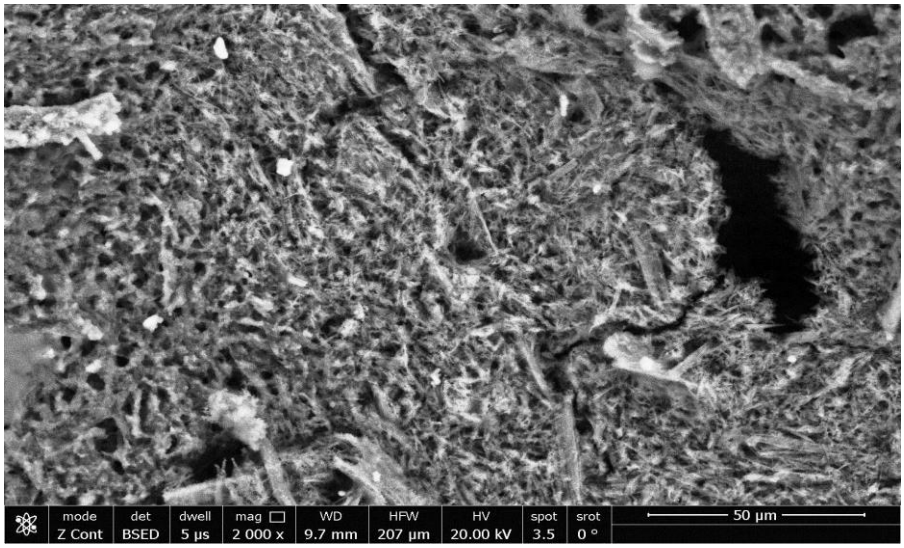

Figure 2: SEM analysis of fabricated membrane

Fourier Transform Infrared Spectroscopy (F-IR)

FTIR (Fourier Transform Infrared Spectroscopy) analysis identifies and characterizes the chemical bonds and functional groups present in a material. FTIR analysis was conducted on a sheet fabricated from natural activated carbon, cellulose from bagasse, and chitosan nanoparticles after testing its adsorption on dye pollutants.

Figure 3 represents the FTIR graph for the manufactured sheet. The x-axis represents the wave number, which is a measure of the infrared radiation frequency used in the analysis, and the y-axis represents the intensity of the absorption peaks. As a result, fabricated sheets have many functional groups available for adsorbing contaminant ions. The absorption of contaminating ions is significantly influenced by these functional groups [1,2]. By analyzing the peaks and their corresponding wave numbers in the FTIR spectrum, scientists can determine the presence of specific chemical bonds or functional groups in a substance, such as hydroxyl groups (OH), carbonyl groups (C=O), or amine groups (NH). All spectra exhibit almost the same shapes in the vibration band characteristics.

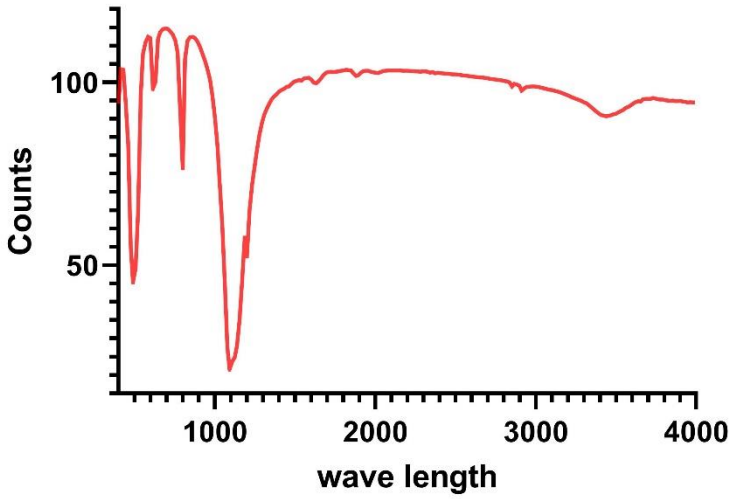

Figure 3: FTIR for fabricated sheet

Conclusion

In conclusion, the development of effective wastewater treatment technologies is essential to address the growing problem of water pollution caused by industrial activities. The use of adsorbent materials, such as the sugarcane bagasse fiber and activated carbon-prepared adsorbent sheet presented in this study, offers a promising and sustainable approach to wastewater treatment. Further research is needed to optimize the design of these materials and to evaluate their effectiveness in treating other types of pollutants. The implementation of these technologies could contribute to the protection of water resources and the preservation of the environment. The sheet showed high potential for removing methylene blue particles, it achieved a removal efficiency of 99.4% for dyes particles, which is providing the effectiveness of the natural membrane for textile wastewater treatment. Using this material as a scaffold for the adsorbent sheet not only reduces waste but also provides a source of income for farmers. Additionally, the use of activated carbon as an adsorbent material enhances the adsorption capacity of the sheet, leading to higher removal efficiencies. In addition to its effectiveness in removing dyes particles, the natural membrane developed in this study was also characterized by BET analysis, which revealed a high surface area of the fabricated membranes (30.5719m^2\g). This suggests that the membrane has a relatively high potential for adsorption, making it a promising material for the removal of various pollutants from wastewater.

Acknowledgment

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Microbial bioremediation of olive mill wastewater enhanced by zerovalent iron Nano-particles

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Keywords: Biofilter, enzymatic microbial bioremediation, Olive mill wastewater (OMWW), phenolic compounds, zerovalent iron Nano-particles (NZVI)
CWW2023 Theme: 3

ABSTRACT

The consumption of olive oil has recently been multiplied worldwide after researchers' latest discoveries of the great dietetic benefits of olive oil for humans' health and well-being. Olive oil production represents a great environmental problem because of the large amount of olive mill wastewater (OMWW) produced. OMWW contains phenolic compounds, which have high toxicity to most of the microorganisms, plants, fish and animals, since it quickly penetrates the skin and may cause severe irritation to eyes and respiratory tracts.

The present study aimed at microbial treatment of olive mill wastewater for phenolic compounds removal enhanced by zerovalent iron Nano-particles and growth factors. The objectives of the study included isolation and purification of microorganisms from OMWW, screening to select and identify the most efficient wastewater-decolorization isolate, optimization of decolorization conditions, enhancement of decolorization activity by zerovalent iron Nanoparticles, glucose and yeast extract supplementation and finally, characterization of the treated wastewater.

Olive Mill Wastewater (OMWW) was obtained from an olive press factory, Giza. Mineral Salt Medium (MSM) was supplemented with different volumes of OMWW as a source of both phenolic compounds and microorganisms. Ten fungi were isolated and used for inoculation of liquid MSM supplemented with 2.5% of OMWW to select the most active isolate. During five days of incubation, the total phenolic compounds, Manganese peroxidase enzyme activity, and the decolorization activity were determined daily, and compared with the non-inoculated medium (control). The most active two fungi were identified by the 18S-rRNA sequencing method as *Aspergillus terreus* (F1) and *penicillium chrysogenum* (F7).

The zerovalent iron Nano-particles were prepared and characterized (Fig. 1, 2). Effect of incubation time, wastewater concentration, the prepared zerovalent iron Nano-particles, and supplementation with glucose and yeast extract on the decolorization activity, Mn peroxidase enzyme activity, and phenolic compounds degradation were investigated. The results showed that *P. chrysogenum* showed the highest phenolic compounds degradation (62.5%) in presence of 0.1% glucose (Fig. 3)

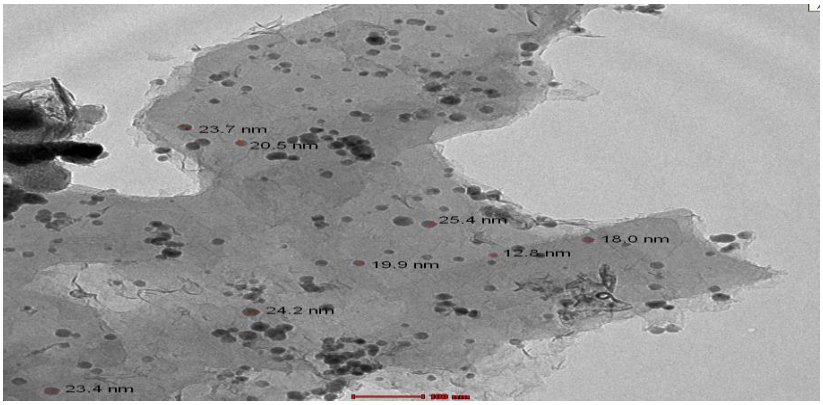

Fig. 1: TEM image of the synthesized NZVI particles, which have a nearly spherical shape with size range about (12-25) nm.

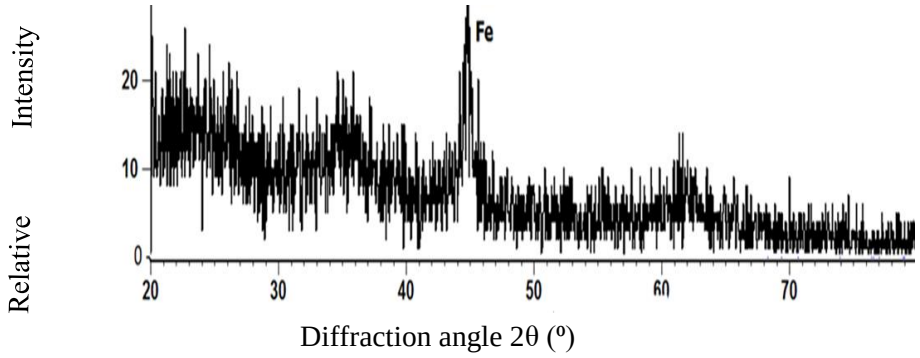

Fig. 2: The X-ray pattern of NZVI reveal an apparent peak at the diffraction angle 2θ value of 45º, which indicated the formation of Nano-iron in the Zerovalent state (Fe^0).

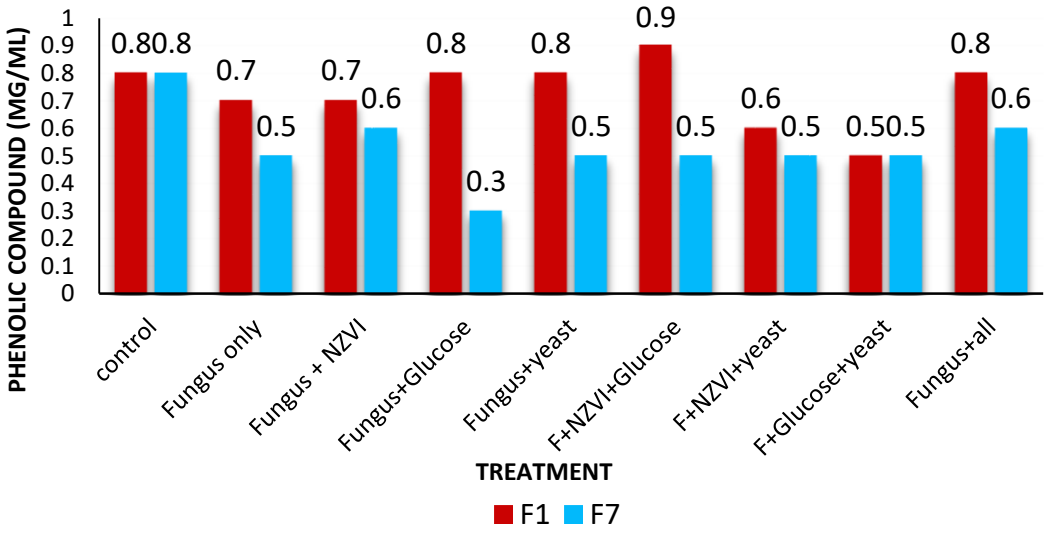

Fig. 3: Phenolic compounds degradation by *A. terrus* (F1) and *P. chrysogenum* (F7) as affected by different treatments.

The wastewater characterization before and after treatment showed that the initial BOD decreased from 1570 mg/L to 558 and 521 mg/L after treatment with F1 and F7, respectively. The COD decreased from 4422 mg/L to 1328 and 1072 mg/L after treatment with F1 and F7, respectively.

This result strongly suggests that *P. chrysogenum* can be used for biological treatment of olive mill wastewater to remove the phenolic pollutants that enables the wastewater recycle.

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Adsorptive recovery of arsenic (III) ions from aqueous solutions using dried *Chlamydomonas* sp.

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Keywords: Arsenic, Bioremediation, Chlamydomonas, Microalgae.
CWW2023 Theme: 3

ABSTRACT

The present study aimed to descry the effectiveness of dried microalga Chlamydomonas sp. for the removal of arsenic from aqueous solution. The study included examining the impact of some factors on algae's adsorption capacity (optimization study), such As initial concentrations of heavy metal, biosorbent doses, pH, and contact time. All experiments have been performed at a constant temperature of 25 ◦C and a shaking speed of 300 rpm. The optimization study indicated that pH 4, contact time at 60 min, temperature of 25 ◦C, and biomass concentration of 0.6 g/l were the best optimum conditions for the bioremediation activity with a maximum removal percentage of 95.2% and biosorption capacity of 53.8 mg/g. Conferming of biosorption by applying FTIR (Fourier transfigure infrared), XRD (X-ray diffraction), SEM-EDX (Scanning Electron Microscope - Energy Dispersive X-ray), DLS (Dynamic light scar- ring), and ZP (Zeta Potential) was conducted. Also, Kinetics, isotherm equilibrium, and thermodynamics were carried out to explain the plausible maximum biosorption capacity and biosorption rate of biosorbent q maximum. The nature of process is endothermic and Crystal form of removed heavy metal observed by SEM proves a reduction mechanism.

The data recorded in Fig. 1 exhibit the elimination capacity of as (III) ions increased gradually from 18.5 mg/g at pH 3 to 28.4 mg/g at pH 4. Through the experimental study about the influence of different pH values on the adsorption capacity of the dry biomass of *Chlamydomonas* sp.

Powder X-Ray Diffraction. X-ray diffraction was performed on Desktop X-ray Diffractometer Rigaku, MiniFlex II. Samples were analyzed in an angular range of 2 theta (10°–90°).

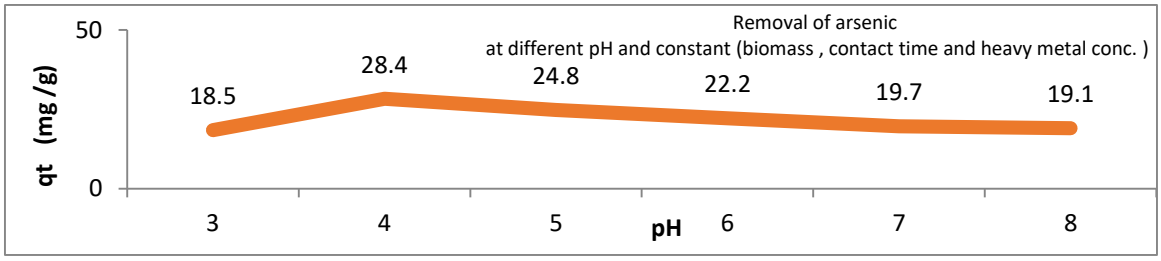

Fig. 1. Effect of pH on biosorption of arsenic by the dried microalgae *Chlamydomonas* sp. at constant time 60 min, biosorbent dose 1 gm/l, temperature 25 ℃ and heavy metal concentration 50 mg/l.

X-ray diffraction is a non-damaging method used to explain details for data on the crystal features arrangement of materials. This technique offers many benefits e.g., high accuracy, non-damaging, and ability to investigate polycrystalline, single crystals, or amorphous substance substances. XRD has been generally involved in the explanation of biosorbent and in the confirmation of the heavy metals biosorption process. By using origin 2018 software which enables us to make a comparison among peaks of biosorbent Chlamydomonas loaded and un-loaded with As (III). Which observed in As-loaded biomass through the newly formed peak at 2θ 18.469 and shifting of peaks at 2θ 20.8837 and 26.6952 to 2θ 21.0653 and 27.9323 respectively. It's confirmed by the reported chart of loaded and unloaded biomass in Table 1. Resulted from patterns of X-ray diffraction of biomass. Prior and post As (III) biosorption process. Peaks with Sharp intensity in the unloaded biosorbent has been found at 2θ = 20.8837, 26.6952, and 29.6743, with d spacing value of 4.25374, 3.33944 and 3.01062. Otherwise, the pattern in the As-bound biosorbent showed the appearance of new peaks at 2θ values of about 13.8043 for As (III) indicating the character of the biosorbent. The XRD data analysis of the unloaded biosorbent illustrates common diffraction peaks.

Table 1. XRD Peaks data features of controlled As (III) unloaded biomass and controlled As

controlled As (III) un loaded biomass					
Pos. [°2Th.]	**Height [cts]**	**d-spacing [Å]**	**Rel. Int. [%]**	**Crystallite Size only [Å]**	**Micro Strain only [%]**
20.8837	107.85	4.25374	62.51	920.3247	0.2311
26.6952	172.53	3.33944	100	927.0256	0.180116
29.6743	105.43	3.01062	61.11	643.4676	0.233937
controlled As (III) loaded biomass					
Pos. [°2Th.]	**Height [cts]**	**d-spacing [Å]**	**Rel. Int. [%]**	**Crystallite Size only [Å]**	**Micro Strain only [%]**
18.469	89.65	4.80408	56.93	48.04762	4.99929
21.0653	110.784	4.21748	83.69	28.93167	7.288699
27.9323	98.623	3.19429	100	344.279	0.46391
33.1376	20.32	2.70347	9.68	410.7689	0.329074

(III) loaded biomass.

The suggested kinetic model for initial heavy metal concentration 25 mg/l is 2nd order, for 50 mg/l is 1st order, for 100 mg/l is elovich, for 140 mg/l is elovich, for 180 mg/l is 1st order and for 200 mg/l is elovich.

Conclusions

The data in this study indicated that Chlamydomonas sp. can be applied as a biosorbent for the removal of As (III) ions from the aqueous solution which is potentially affected by

parameters such as pH, contact time, biosorbent dose, temperature, and initial metal ion concentration. The study in these explorations of colorful styles of removing heavy metal are delved and the birth approach is a stressed medium of this mechanism. Likely it was used as a powerful biosorbent material (0.6 g/l concentration) for removal of As (III) from aqueous solution up to 200 mg/l at a temperature 25 ◦C and pH 4. Isotherm Kinetic models and thermodynamics were successfully used for mathematical purposes of biosorption of arsenic ion (III) to dried biomass. Characterizations of biomass using FTIR, XRD, SEM-EDX, TEM, DLS, and zeta potential prove that bio- sorption process occurred. Finally, it was conscripted that Chlamydomonas sp. is effective, reusable, low cost, and environmentally friendly as a biosorbent factor for As (III) ions removal from aqueous solution.

Acknowledgment
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Bioaccumulation of Toxic Metal Pollutants by Water Velvet and Effects on Pigment Content

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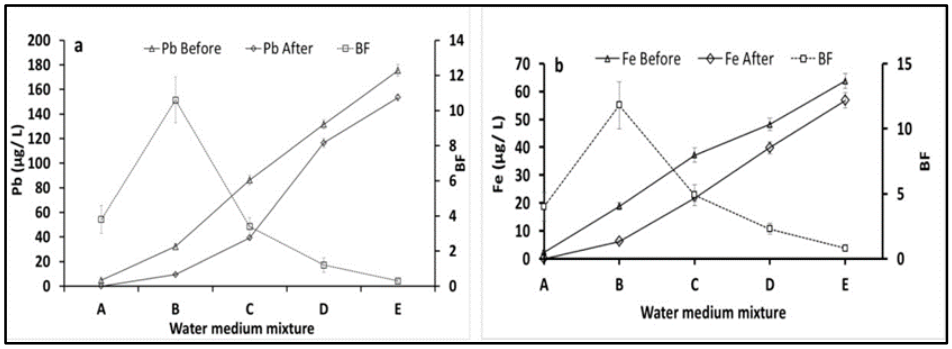
Keywords: *Azolla pinnata*, Bioaccumulation, Carotenoid, Chlorophyll, Removal Efficiency, Wastewater
CWW2023 Theme: 3

ABSTRACT

Phytoremediation is currently considered as a cost-effective green technology for both water and soil remediation. This study aims at evaluating the fern Water Velvet in remediating five toxic metals Pb, Fe, Zn, Ni, and Cu. The fern was cultivated in freshwater, wastewater, and mixtures of wastewater-freshwater. The bioaccumulation factor was higher than unity and up to 19.6 for Ni and averagely 14 for Zn and Cu. The experimental results showed that the removal efficiency reached 98% in freshwater and within the range of 10-17% in wastewater. The decrease in pigment content of chlorophylls a and b and carotenoids is coupled with the increased toxic metal concentrations. The chlorophyll a/b ratio was greater than unity in water mixtures, while in fresh or wastewater, the ratio was less than unity. The toxic metal bioaccumulation is coupled with decreased pigment content, indicating the fern's potential use as a bioindicator of toxic metals pollution.

Table 1: Removal efficiency of different toxic metals by *Azolla pinnata* from fresh (F) and wastewater (S) and their mixtures. A= 100% F, B= 75% F:25% S, C= 50% F:50% S, D= 25% F:75% S, and E= 100% S. (n= 5± SE)

Toxic metals	% Removal efficiency in different water media				
	A	B	C	D	E
Pb	98.3± 1.2	70.8± 3.7	54.4± 3.5	11.5± 0.6	**12.5± 1.2**
Fe	97.9± 1.4	69.2± 4.6	41.3± 1.6	17.4± 0.8	**10.9± 0.8**
Zn	-	55.8± 2.5	43.7± 2.5	11.6± 0.7	**10.5± 0.6**
Ni	98,8± 0.6	59.5± 3.8	34.2± 1.4	36.5± 1.9	**17.3± 1.1**
Cu	**98.3± 0.4**	**38.8± 2.7**	**25.7± 1.8**	**47.8± 3.1**	**12.8± 0.5**



A= Fresh water, B= 75% Fesh-25%Wastewater, C= 50% Fresh-50% Wastewater, D= 25% Fresh-75% Wastewater, and E=Wastewater

Figure 1: Removal and bioaccumulation of the toxic metals Pb and Fe (a and b) by Azolla pinnata from fresh-wastewater mixture.

The results showed that the bioaccumulation and removal efficiency decreases at higher concentrations of toxic metals in the water medium. A similar trend was found in the pigment content where chlorophyll *a* and carotenoids content decreased, and chlorophyll *b* increased with the increase of toxic metal concentration. The bioaccumulation and removal efficiency was higher at lower toxic metals concentrations, which may indicate the driving force exerted by the concentration gradient that resists the transfer of the metals between the aqueous medium and the living tissues of Water Velvet.

Sood *et al*. (2012) reported that bioaccumulation might not be a viable option for phytoremediation at high concentrations of the toxic metals as the bioaccumulation is closely connected with their toxicity, affecting plant and its growth, where once the metal concentration becomes too high, the amount of toxicant accumulated will attain a saturation level. In conclusion, the fern Water Velvet poses a great potential to be used as phytoremediator species in aquatic bodies having low toxic metals pollution.

It is also recommended that the fern can be employed as phytoremediator of toxic metals in industrial and municipal wastewater ponds before dumping to the drainage system or recycled. As a bioindicator, the variations in pigment content in response to toxic metal concentration in water is useful in monitoring the pollution level in aquatic ecosystems before applying sophisticated and costly techniques or conducting long term field and laboratory experiments.

Acknowledgment

We thank Dr. Nabil Ibrahim and Dr. Ali Mekki for their kind support with the statistical analysis and data interpretation.

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Removal of Lead by Metal Resistant Bacteria and Fungi Isolates from Cement Industrial Wastewater. A Case Study for Isolation of *Staphylococcus Aureus and Aspergillus Niger*

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Keywords: Pb^{2+}, Green technology, *Staphylococcus aureus and Aspergillus niger*, Resistance,ICPs.
CWW2023 Theme: 3

ABSTRACT

Resources reuse has become an important feature of wastewater management. Industrial wastewater mainly from paint, leather, metal, and tanning industries contain huge amounts of heavy metals. As conventional methods to remove metals from aqueous solutions are not effective enough mainly at low metal concentration and too expensive, alternative methods are required. Green technology such as using microorganisms including bacteria and fungi have been reported to remove heavy metals from industrial wastewater through bioaccumulation and biosorption at low cost and in eco-friendly way. Current study showed that *Staphylococcus aureus and Aspergillus niger* were isolated from cement industrial wastewater sample in Egypt. These isolates exhibited high efficiency in removal of Lead (Pb^{2+}) from wastewater, and they can tolerate up to 500 ppm concentration of Pb^{2+}. Both bacterial and fungal isolates showed high efficiency in removing Pb^{2+}, this was confirmed by inductively coupled plasma analysis. Different concentrations of Pb^{2+} (30, 50, 150, and 500 ppm) were prepared for bacterial and fungal isolation from industrial cement wastewater on nutrient agar and rose-bengal media, respectively. Above mentioned bacterial and fungal isolates were cultured in the Ni -polluted media and the remaining concentration of metal ions in the media was measured after 5 days growth, using inductively coupled plasma. Results showed that 5.50% removal of Pb^{2+} was done after 5 days by *Staphylococcus aureus*. and 5 % removal after 5 days by *Aspergillus niger*.

Results

Bacterial Identification

Biochemical identification using Vitk2: *Staphylococcus aureus*

Measurements of bacterial biodegradation efficacy of Lead gradually for 5

days results by ICB:

Table.1. Concentration of Lead on the Media

Time (hrs)	Measurement bio removal efficiency of Pb. (ppm)
24 hrs	31.065ppm
48 hrs	32.4ppm
72 hrs	39.9ppm
5 days	47.25ppm

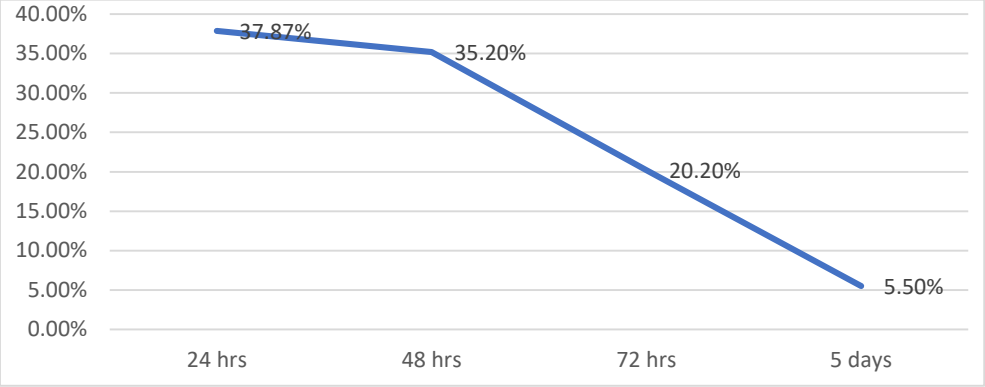

Figure 1. Green removal of lead by *Staphylococcus aureus*

This chart discusses that *Staphylococcus aureus* makes bio removal in 5 days and the bacteria in first 24hours show high efficiency bio removal and decrease lead concertation but in 48 hours the efficiency decrease

Fungal Identification

Biochemical identification using Vitk2: Aspergillus niger

Measurements of fungal biodegradation efficacy of Lead gradually for 5 days results by ICB:

Table 2 . Concentration of Lead in the Media

Time (hrs)	Lead conc. (ppm)
24 hrs	24.75ppm
48 hrs	29.65ppm
72 hrs	40.90ppm
5 days	47.50ppm

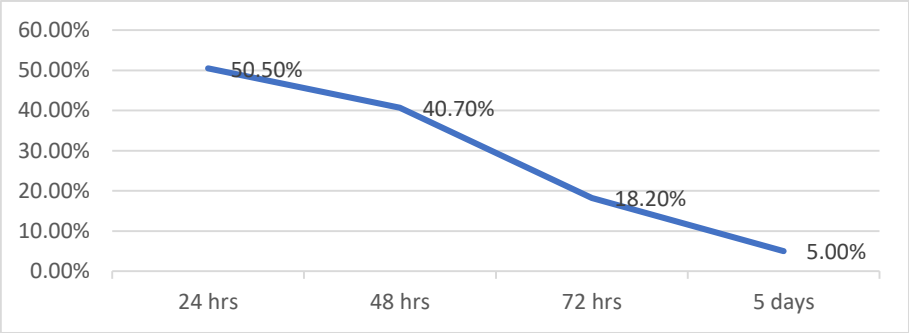

Figure 2. Green removal of lead by *Aspergillus niger*.

This chart discusses that the *Aspergillus niger* makes bio removal in 5 days and the fungus in first 24hours show high efficiency bio removal and decrease lead concertation but in 48 hours the efficiency decrease.

Conclution

Results conclude that both microbial isolates of bacteria and fungi are very important in decreasing of lead ions. They have bio removal potency under various pH and concentration conditions, adsorption of heavy metal ions by a microbe surface are reversible. The ions can be desorbed from the microbe cell surface at low pH Also, could be further applying as biosensor for detecting lead pollutants at different concentrations in industrial wastewater field.

Acknowledgment

The author thanks Dean Prof. Dr.Hala Eissa of College of Biotechnology and our supervisor Professor Doctor Mahmoud Wafik Sadik for help with the experiments.

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Geochemical Speciation, Ecological Risk and Assessment of Cadmium Metal Concentration of Water and Bottom Sediments from Nile River in Egypt

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Keywords: Cadmium, Fractionation, Heavy Metals, Nile River-Egypt, Sediments, Water Pollution
CWW2023 Theme: 3

ABSTRACT

Heavy metals such as cadmium (Cd) pollute the environment. Heavy metal pollution endangers the Nile River since it serves as an irrigation and freshwater source for the cities and farms that line its banks. Water and sediment samples from the Nile River were tested for Cd content. In addition, a sequential experiment analytical method was performed to determine the metal's relative mobility. According to the data, there is an average of 0.16 $mgkg^{-1}$ of Cd in sediments. BeniSuef water treatment plant and brick factory, iron and steel factory of Helwan, oil and detergent factory of Sohag, and discharge of cement factory in Samalut had the greatest concentration of Cd in their vicinity. According to the risk assessment code, there are three categories of Cd: residual (57.91%), acid-soluble (27.11%), reducible (11.84%), and oxidizable (3.14%). Bioavailable and mobile Cd levels in sediment and water were found in Beni Suef, Aswan, Helwan, Samalut, Sohag, and Helwan. Because the other metal is highly bioavailable, its concentration is not a risk factor in Samalut station. Cd's toxicity and bioaccumulation make it an extra hazard to aquatic animals and human life. There should be a deterministic approach to monitoring Cd near industrial sources.

This study aimed to analyze the current concentrations of Cd in Nile waters and sediments, illustrating its distribution and potential sources, determining the degree of contamination, and how much Cd is bioavailable. As a result, this study will help better understand the current state of the environmental impact of heavy metals along the Nile River.

Materials and Methods

Study Area

A total of 11 African countries, including Egypt, share borders with the Nile River, covering a distance of 6,650 kilometers, which flows into the Mediterranean Sea. For decades, this river has been a vital primary source of freshwater for humans and animals and a source of irrigation for the dry country around it. Today, the river still provides irrigation and serves as a vital transit and trading route. At the same time, toxic substances are being discharged into the river. The White, Blue, and Atbara Nile Rivers entered the main Nile. Arabian–Nubian Shield Basement rocks, Phanerozoic sedimentary cover, Ethiopian Highlands (basalt), and aeolian sources from the highlands of the Red Sea of Egypt supply sediments to the Nile's trunk [1-2]. The Nile River provides 80 to 85% of water for the agricultural

sector and 65% of the water needed for industrial purposes, and it receives over 57% of the effluents generated [3]. The Nile receives massive amounts of agricultural effluent, which contains a variety of chemical contaminants related to the common use of fertilizers and pesticides. Significant Cd pollution in the Nile River bottom sediments between Aswan and Esna, near the phosphate shipping harbors [4]. The Nile River and its tributaries are pretentious by various human-caused activities, including the disposal of sewage sludge and wastewater, agricultural activities, industrial processes, and the use of phosphate fertilizer [5-7]. According to Egypt's Nile River studies [8&9], hazardous metals such as Cd, Pb, and Fe have been found in important economic fish species, aquatic plants, and water. Increasing pollution and dwindling Nile water levels are Egypt's most pressing issues, especially with completing the new dam construction project.

Sampling and geochemical analysis

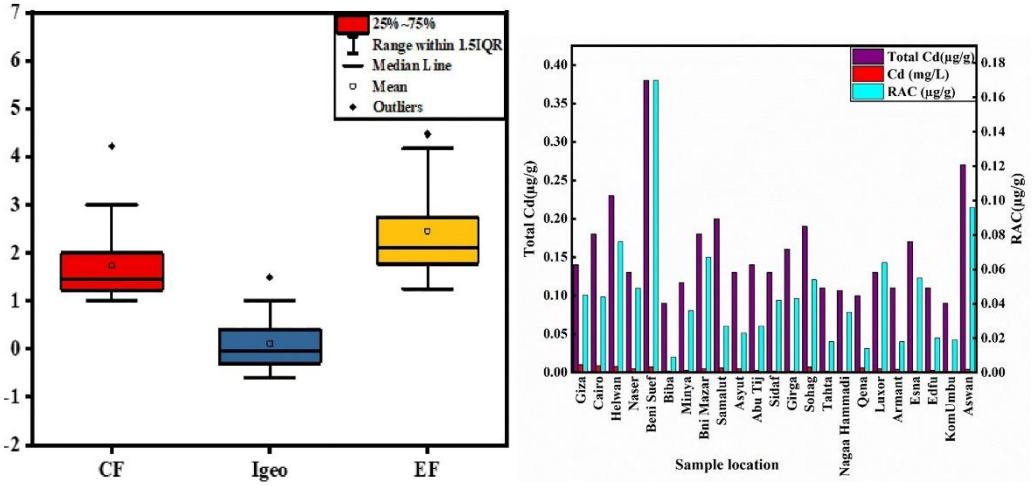
In September 2019, 23 representative sediment and water samples (from two banks and the middle) were carefully selected from Aswan to Cairo (Figure 1) to evaluate Cd concentration and fractionation in the bottom sediments and determine the anthropogenic sources of pollution along the river. A grab sampler (Ekman type) was used to capture the sediments rinsed between sites with distilled water. In an oven at 70°C, the sediments were dried for around 26 hours before being kept for chemical testing. A GPS tracker was utilized to locate the sampling locations' latitude and longitude and their elevations. This method of analyzing the total Cd content in sediments uses a chemical reaction involving the digestion and addition of HCl, HNO_3, and 2mL HF to 0.25 g of dry sediment. Finally, the digested solutions were subjected to inductively coupled plasma mass spectrometry (ICP-MS) (Agilent 7900, USA) and inductively coupled plasma atomic emission spectroscopy (ICP-AES) (Agilent 5110, USA) analysis at ALS CEMEX (Guangzhou) Co., Ltd-China, respectively. To monitor the state of the equipment and ensure quality, a reference solution was measured after every five samples were analyzed. Every chemical reagent was utilized of analytical grade.

Using a waterproof (PH/EC/TDS) and portable temperature meter, the pH, temperature, and total dissolved solids (TDS) of water samples were evaluated simultaneously with the collection of water samples using a portable meter of (HI98129.HI98130, HANNA, USA). Before the experiment, the PH meters were calibrated with standard solutions. A professional waterproof portable PH/ORP Meter (HI98190, HANNA USA) was used to determine the oxidation-reduction potential (ORP). All samples were acidified with ultrapure HNO 3 acid in a 30 mL LDPE bottle that was washed with ultrapure water and 10 % HNO 3 acid. Both the acid and the water used were of the highest quality. Temperature-controlled storage was employed for storing water samples at a temperature (4°C) before analysis, as per standard procedures [10]. ICP-MS was used to determine the amount of Cd in the water samples.

Conclusion

Heavy metal pollution endangers the Nile River since it serves as an irrigation and freshwater source for the cities and farms that line its banks. Cd pollutes the environment and is toxic at low concentrations. The Cadmium average in sediments is (0.16 $mgkg^{-1}$). The most significant concentrations had recorded at Benisuef (0.38 $mgkg^{-1}$), Aswan (0.27 $mgkg^{-1}$), Helwan (0.23 $mgkg^{-1}$), Samalut (0.2 $mgkg^{-1}$), and Sohag (0.19 $mgkg^{-1}$). The pollu-tion level of Cadmium in sediments is moderate to high at all samples stations along the river. The concentration and distribution of Cd in rivers are affected by the vicinity of an-thropogenic

sources such as household waste, sewage sludge, agricultural runoff, and industrial activity. The Cd fractions follow this descending order: residual (57.91%), ac-id- soluble (27.11%), reducible (11.84%), and oxidizable (3.14%). The high cadmium concentration in water was recorded at Cairo, Giza, Helwan, Beni Suef, Sohag, Qena, and Samalut with values (0.009, 0.01, 0.008, 0.007, 0.007, 0.006, and 0.006 mgL^{-1}, respectively) more than standard limits. Beni Suef, Aswan, Helwan, Samalut, and Sohag all have sig-nificant bioavailability and mobility of Cd in sediment and high content in water. Accordingly, the river's contamination must be thoroughly investigated, particularly in the vicinity of industrial points of origin in the areas precisely stated. Cd's primary effects on the environment and human health can be summarized as ecosystem contamination and exposure-related health issues. Egypt's high Cd concentration could become a problem if it is not carefully managed. We argued for continuing studies on aquatic organisms and humans in these places.



Figures: Box plot of Contamination factor (CF), geo-accumulation index (I_{geo}), and enrichment factor (EF) according to (McLennan, 2001) Nile River sediments (left figure) and Relation between Concentration of Cd in sediments ($mgkg^{-1}$) $mgkg^{-1}$and Water mgL^{-1} with risk assessment code (RAC) ($mgkg^{-1}$) of samples along Nile River- mainstream(right figure).

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CWW2023 – CAIRO
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Multitreatment Plant

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Keywords: Moringa, Reverse osmosis, Sewage, Sodium hydroxide, Sodium hypochlorite
CWW2023 Theme: 3

ABSTRACT

Currently, the world is suffering from a variety of dilemmas that threaten mankind's survival. One of the most complex issues and perilous ones is water scarcity. As more than two billion humans around the planet do not have access to drinkable water, making water mixed with sewage and impurities their only source of water. Nevertheless, freshwater resources on the planet are limited to rivers and groundwater only. Therefore, alternative sources of fresh water must be found. Furthermore, scientific efforts are not yielding the intended outcomes due to the massive population growth rate, which increases the amount of water consumed. Researchers found that every year there is about "1.5*10^15" liters of sewage water produced. Some of it is discharged into rivers around the world which contributes to increasing the toxins in drinking water. Hence, we aspire to spread around purified sewage water valid for human use. This can be accomplished by carrying the water through several processes including chemical, biological, and physical treatments. Using red bricks, sand, gravel, and charcoal as a primary treatment. Then, Using Moringa seeds to get rid of the heavy metals. After that, treating the water using sodium hydroxide and sodium hypochlorite to remove organic matter and microorganisms respectively. Lastly, we carry out reverse osmosis to remove the rest of chemicals and harmful elements, producing water free of impurities and poisonous materials. By comparing the water parameters before and after the purification processes, an enormous change is observed, making it the first infinite water reuse process.

Table 1: Prices of Materials

No. (Quantity)	Item	Price
4	Acrylic box(S)	200L.E
2*0.1*0.01 (m)	wood	20L.E
1	Reverse Osmosis system	120L.E
1	Water pump motor	100L.E
5	Water taps	50L.E
1	Silicon	30L.E
1	Filtration paper	1L.E
0.25 Kg	Charcoal	5L.E
2	Super glue	10L.E
1	Water pipe	10L.E
1	Moringa seed	1L.E
0.0016 Kg	Sodium hydroxide	1L.E
0.01L	Sodium hypochlorite	1L. E
1	Paint	20L.E

Table 2: Water parameters

Parameters	pH (Power of hydrog-en)	TDS (Total Dissolv-ed Solids)	TSS (Total Suspe nd-ed Solids)	COD (Chemi-cal Oxygen Deman d)	BOD (Biochemi-cal Oxygen Demand)	Coliform	Water hardness
Unpurified water	5.1	875 ppm	708 ppm	456 mg/L	148 mg/L	14000 (MPN/1 00 ml)	4.19 mg/L
Purified water	7.2	0.000001 7 ppm	Null	11mg/L	3.8 mg/L	Null	<0.1 mg/L

Figure 1: Real photograph of the prototype

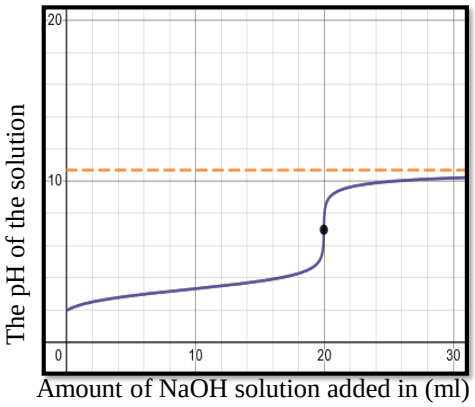

Figure 2: Titration graph

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Meta bacteria: An investigation of the potential of microorganisms to treat dairy wastewater and generate biohydrogen

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Keywords: Biohydrogen, Biological treatment, Bioremediation, Dairy wastewater, Sustainability
CWW2023 Theme: 3

ABSTRACT

Dairy production is a significant contributor to the global water crisis due to the large amount of wastewater generated in the industry. In many parts of the world, dairy processing plants lack proper wastewater treatment facilities, leading to the discharge of untreated or partially treated wastewater into nearby water bodies. This practice can have severe environmental and public health consequences, including water pollution and the spread of waterborne diseases; hence, numerous technologies and methods have been developed to achieve the best possible outcome for treated dairy wastewater like coagulation, screening, filtration, and chlorination. However, they did not prove high efficiency with dairy wastewater. Biological treatment processes such as bioremediation, activated sludge, and aerated lagoons have been proven to be the most suitable treatment methods. Bioremediation is a novel technique that is based on the use of microbes or their enzymes to restore a contaminated environment to its natural state. It can be applied in two ways: In Situ and Ex Situ.

In Situ, Bioremediation is the most common method of bioremediation, which involves ejecting the bacterial medium into the local site of the treated wastewater present in the dairy effluents. However, Ex Situ Bioremediation, which we used in our research, is more efficient and requires less time. Microorganisms utilized in bioremediation may be indigenous to the polluted region or isolated from other sources and transported to the contaminated location. A laboratory model was developed to investigate the capacity of several well-adapted local microorganisms (bacteria and fungus) isolated from dairy wastewater to break down organic nutrients and enhance the physicochemical quality of dairy wastewater. The model was reinforced with natural filtering medium (rice straw and activated carbon).

We did not just treat the dairy wastewater; however, we started investigating a method that can harness the wastewater and use it as a source of energy, which was biohydrogen. Biohydrogen production can be classified into biophotolysis of water using cyanobacteria and green algae, dark fermentation using anaerobic bacteria, photo fermentation using photosynthetic bacteria, and microbial electrolysis cell (MEC) using wastewater to produce hydrogen using a membrane between an anode and a cathode in an MEC configuration.

Photo fermentation is the process we chose, which depends on converting most organic acids or VFA to biohydrogen and carbon dioxide under anaerobic conditions with illumination. The major enzymes responsible for the biohydrogen metabolism in purple non-sulfur

bacteria are nitrogenase and hydrogenase. The light-harvesting vesicular, lamellar, and stacking photosynthetic pigments (antenna pigments) are found in the PNS bacteria's photosynthetic system, which is in the cell membrane. Rhodobacter sphaeroides is an ideal candidate for photo-fermentative hydrogen production due to its unique features, including efficient light harvesting, high hydrogen production rate, organic acid production, and environmental stress tolerance. Rhodobacter sphaeroides has a high efficiency of light harvesting due to its unique pigment composition, which enables it to capture a broad range of light wavelengths.

The wastewater samples were collected from the Obour Land dairy factory in Al-Obour City, with a concentration of 40% v/v. They were stored at 4^{o}C inside an ice box and transferred immediately to the laboratory for further experiments. The bacteria were isolated from the factually of agriculture at Ain Shams University. The untreated dairy wastewater was initially filtered through cotton wool, sterilized at 120^{o}C for 20 min, and then filtered with a narrow pore paper filter.

The biomass of actively developing cells was generated to examine the biodegradation efficiency of the microbial isolates. Each isolate's active developing culture was washed three times with sterile deionized water and centrifuged at 10,000 rpm for 10 minutes to get a moist pellet. The pellet was resuspended in sterile deionized water until the turbidity reached or exceeded the McFarland 0.5 Standard. After inoculation, flasks were incubated at 35C on a rotary shaker for 24–48 h. After incubation, single pure colonies were suspended in nutrient broth containing 10% (v/v) glycerol and stored at -4C for identification and further experiment.

Photoheterotrophic bacteria of Rhodobacter sphaeroides O.U. 001 were cultivated on Van Neil's medium containing Dipotassium hydrogen phosphate, Magnesium Sulphate, Yeast Extract, and Final pH (at 25°C). The biodegradation process involves oxidation-reduction, adsorption processes, ion exchange, and chelation reactions, which result in metal accumulation. With the right nutritional and environmental conditions, native microorganisms or bio-augmentation can accelerate hydrocarbon biodegradation.

Table 1. Biohydrogen generation results

Inoculum Concentration (g dry wt./l)	H2 Production Rate (l/l/h)	pH Final	COD Loss (%)	Light Conversion (%)	Biomass Increase (g/l)
0.35	0.152	7.1	21	7.9	1.2

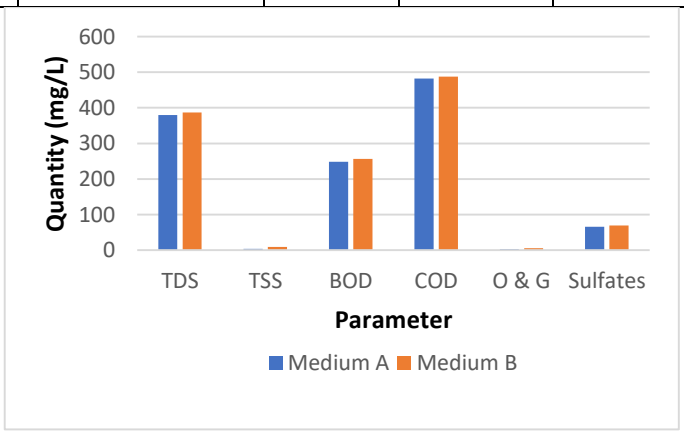

Figure 1. A comparison between the degradation potential of both mediums A and B

Our project has an incredible potential to treat the organic-rich dairy wastewater with up to 72.4% removal efficiency of COD, 74.2% removal efficiency of BOD, and 44.5% removal efficiency of oil and grease, which is much more efficient than other prior methods used to treat dairy wastewater. As it does not need much electric supply like the electrocoagulation process, which needs about 60V voltage supply to reach its optimum efficiency. Furthermore, it is more efficient than

activated sludge, which also depends on bacteria. As activated sludge has a 65% removal efficiency of COD and 67% removal efficiency of BOD. For the sake of real-life application, we recommend applying the idea of our project as a bio-solar panel combined with a water treatment plant. This idea can be significantly useful due to a variety of characteristics of the project. First, it provides both a source of green energy which is biohydrogen, and a source of pure water for household activities.

Acknowledgment

We would like to express orr sincere gratitude to Dr. Asmaa AbouelKheir and Dr. Jamila Eltaweel from the National Research Center for their invaluable supervision, guidance, and support throughout the project. Their expertise and insight have been instrumental in shaping the direction of this research and ensuring its successful completion. We would also like to thank the microbiology department in the faculty of agriculture at Ain Shams University for their generous donation of the bacterial samples.

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CWW2023 – CAIRO
Cairo, 29 Oct- 2 Nov, 2023

Study Antimicrobial, Antioxidant and Anticancer Activities of Biosynthesized Silver Nanoparticles Produced by *Phormidium ambiguum* and *Desertifilum tharense*

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Keywords: Cyanobacteria**,** *Phormidium ambiguum*, *Desertifilum tharense*, Ag-NPs, biosynthesis, characterization, antibacterial, antioxidant.
CWW2023 Theme: 3

Abstract

The world faces a challenge with the pervasion of multidrug-resistant bacteria that encouraged the scientists to develop and discover alternative ecofriendly and easy to produce new antibacterial agents. Two Egyptian cyanobacteria were isolated and identified according to 16S rRNA gene sequencing as *Phormidium ambiguum* and *Desertifilum tharense*. The sequences were deposited with accession numbers MW762709 and MW762710 for *Desertifilum tharense* and *Phormidium ambiguum*, respectively in the GenBank. These isolates can produce silver nanoparticles (Ag-NPs) extra- and intracellularly under light and dark conditions. The results of UV-Vis analysis showed promising extracellular Ag-NPs synthesis by *Desertifilum tharense* and *Phormidium ambiguum* under light conditions. Therefore, these Ag-NPs were characterized and evaluated for antibacterial and antioxidant activity. TEM, SEM, and XRD analyses revealed the spherical crystals with face-centered cubic structures and size range of 6.24–11.4 nm and 6.46–12.2 nm for Ag-NPs of *Desertifilum tharense* and *Phormidium ambiguum*, respectively. XRD and EDX results confirmed the successful synthesis of Ag-NPs in their oxide form or chloride form. The FTIR spectrum data confirmed the presence of hydroxyl and amide groups. *Desertifilum tharense* Ag-NPs displayed the largest inhibition zone ranged from 9 mm against *Micrococcus luteus* ATCC 10240 to 25 mm against methicillin-resistant *S. aureus* (MRSA) ATCC 43300. For *Phormidium ambiguum* Ag-NPs, the inhibition zone diameter was in a range of 9–18 mm. The Ag-NPs of *Phormidium ambiguum* were exhibited the highest scavenging activity of 48.7% comparing with that of *Desertifilum tharense* that displayed 43.753%. Furter, antioxidant and anticancer on different cell lines were done and data are proceeding.

Two natural earth crust samples were collected from Giza Governorate, El-Haraneya near the ring road in locations between the longitude of 31° 10' 15" and latitude of 29° 58' 20" for the first sample, and longitude of 31° 9' 59" and latitude of 29° 57' 57" for the second sample.

The enrichment culture technique was applied to isolate cyanobacteria, 1gm of each green earth crust sample was dispersed aseptically added to 25 ml of liquid BG-11 medium (Rippka et al., 1979) inside a horizontal falcon tube. The inoculated medium was incubated under continuous illumination using Philips Fluorescent white lamps at a relatively low light intensity (400 -500 lux) at 30°C for ten days. Different methods are used to obtain cyanobacteria monocultures (pure culture), that depending on the cyanobacteria shape (coccoid or filamentous), cell size, and the degree of motility. A pure culture is not always possible because cyanobacteria may have such relationships with other microorganisms. The single filament technique was used to obtain axenic cultures of filamentous cyanobacteria. Whole trichomes or hormogonia will glide on the wall of the tube through few days. This technique was applied by picking these individual migrating trichomes using a Pasteur pipette, and then the single filament was cleaned with the sterile liquid medium in a petri dish. For more purification: first, the motile filamentous cyanobacteria were dragged inside the BG-11 agar medium, allowing them to glide away, then remove any attached contaminations as described by Waterbury (2006). Some rapidly glid filamentous can clean themselves from any bacterial contaminants within hours of inoculum. Then, the purified isolates were transferred in flasks containing 250 ml of liquid BG-11 (pH 7). All pure isolates were maintained under photoautotrophic growth conditions as aforementioned.

The pure isolates were characterized by the preparation of a wet portion which was examined microscopically (Rippka *et al*.,1979). The filamentous nature, size, shape of vegetative cells, presence of heterocyst, and akinetes were identified. The cyanobacterial isolates were identified according to 16S rRNA sequencing. The isolates were cultivated in BG-11 broth for 30 days. After centrifugation of the broth culture at 6000 g for 10 min, the harvested biomass was washed three times using 0.85% NaCl saline solution, and genomic DNA was extracted using GeneJET Genomic DNA purification Kit (ThermoFisher Scientific, Republic of Lithuania). The purity of extracted DNA was checked using both UV-Vis NanoDrop spectrophotometer (NanoDrop 2000, ThermoFisher Scientific, Germany) and agarose gel electrophoresis (Bio-rad, USA).

The 16S rRNA gene fragments were amplified using the cyanobacteria specific primers CYA106F (5′-CGGACGGGTGAGTAACGCGTGA-3′) and CYA781R (5′-*GACTACWGGGGTATCTAATCCCWTT*-3′) (Koo et al., 2019). The amplification step was performed using Thermal cycler PCR (Bio-Rad T100, USA). The PCR conditions for the 16S rRNA gene were: initial denaturation step at 95ºC for 12 min, followed by 30 cycles of 94ºC for 1 min, 56ºC for 1 min, and 72ºC for 2 min, and one extension step at 72ºC for 10 min. The PCR products were checked via agarose gel electrophoresis, purified using a gel extraction kit, and sequenced by Macrogen, Inc., Seoul, South Korea by an automatic ABI 370×1 DNA Sequencer (Applied Biosystem, USA). The sequences were analyzed applying BLAST V2.0 software (http://www.ncbi.nlm.nih.gov/BLAST/).

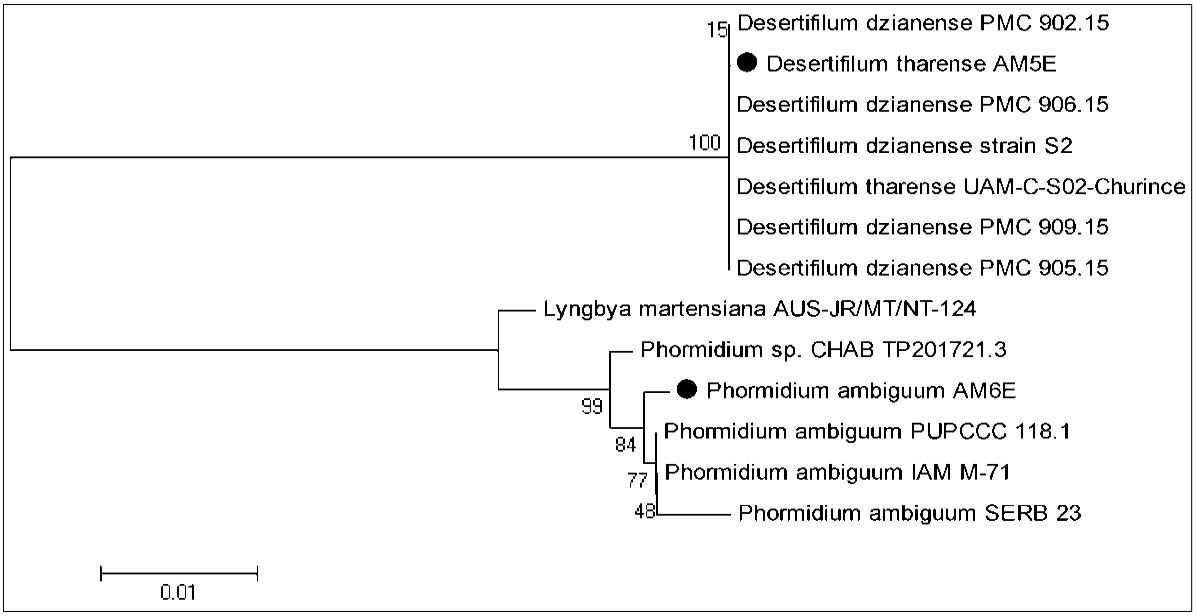

Fig. 1 A neighbor-joining phylogenetic tree (dark circles) with the closest hits obtained from the NCBI gene bank.

Conclusion

In this study, Egyptian cyanobacterial isolates of *Desertifilum tharense* and *Phormidium ambiguum* are found to be potent for the green synthesis of Ag-NPs extra- and intracellularly under light and dark conditions. They can produce smaller spherical particles with face-centered cubic structures. The presence of amides and hydroxyl groups indicates that proteins and polysaccharides could be considered important factors in the Ag-NPs biosynthesis. Generally, the characterization assay showed that a Novel *Desertifilum tharense* cyanobacteria have superior power in the green synthesis of Cyno-AgNPs. The current findings indicate that Ag-NPs may be potent antibacterial agents against different pathogenic bacteria and could use as alternatives to antibiotics. Further studies will recommend knowing the optimal conditions for Ag-NPs biosynthesis. Also, more biological characterizations and *in vivo* experiments are required to establish the real potential for their application in the medical and food sectors.

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Water-Energy/Energy-Water Scarcity Scientific and Policy Trade-offs

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Keywords: Climate, Energy, Hydropower, Nexus, Sustainability, Water
CWW2023 Theme: 3

ABSTRACT

In September 2015, with unachieved Millennium Development Goals (MDGs), the United Nations General Assembly adopted the 2030 Agenda for Sustainable Development with 17 Sustainable Development Goals (SDGs), which jointly constitute a comprehensive plan of action to eradicate poverty and ensure sustainable development.

Talking Water, the 6th goal of sustainable development is to ensure availability and sustainable management of water and sanitation for all. More specifically, 8 targets need to be attained by 2030: Achieve universal and equitable access to safe and affordable drinking water for all. While talking energy, targets 7.1 to 7.3, by 2030, are to ensure universal access to affordable, reliable and modern energy services, increase substantially the share of renewable energy in the global energy mix, and double the global rate of improvement in energy efficiency. Achieving these targets in the two sectors is vulnerable if wrong decisions and ineffective approaches were taken at national and international levels. The importance of energy and water and their strong interdependence have become more evident during the COVID-19 world crisis of 2020 and the world economic battle after the Russian-Ukrainian War. Adding the threats of climate change, without the critical services of water and energy, the full spectrum of living could not be implemented.

In the following part, this paper demonstrates several international perspectives concerning both the water and energy sectors and developed solutions. Those prespectives are documented and published from reputable international organizations specialized in the mentioned issues. One aspect that links water and energy is hydropower which is the largest single renewable electricity source today, providing 16% of world electricity at competitive prices. It dominates the electricity mix in several countries, developed, emerging or developing. While, Bioenergy is the single largest renewable *energy* source today, providing 10% of world primary energy supply (facts, on the UN Environment Program website).

Hydropower has been the leading source of renewable energy across the world, accounting for up to 71% of this supply as of 2016 [1]. This capacity was built up in North America and Europe between 1920 and 1970 when thousands of dams were built. The hydropower industry moved to building dams in the developing world and since the 1970s, began to build even larger hydropower dams along the Mekong River Basin, the Amazon River Basin, Congo River Basin, and the Grand Ethiopian Renaissance Dam (GERD). This paper spots the light on that when having global targets such as SDGs, and the scientific facts that change by time so targets may change as well. Both scientific debates and/or countries policy direction does not go with total respect of science and knowledge.

Political and/or economic decision of building large dams did not respect scientific proofs or environmental threats is the following: 1;large dams stopped being built in developed nations, because the environmental and social concerns made the costs unacceptable (USA and Europe), 2; impacts of large dams specifically built for hydropower generation in terms of design, costs, did not consider sustainable economic and environmental feasibility specially in Up-stream countries in a shared river basin, 3; the projected future change of occurrence of floods and or droughts will jeopardize the dam objective with its long span of construction and its very huge investments (Figure 1) (in a decade cost of other renewable energy will be less), 4; ignoring both environmental/social impact assessments (EIAs &SIAs that serve citizens not builders) that probably stop a dam from being built, and better governance that needs to be created around dams and greater transparency with society about the true costs and benefits inclusively. Development research proved that innovative technologies that do not require damming the river or resettling population are needed. Addressing these issues can transform the hydropower sector.

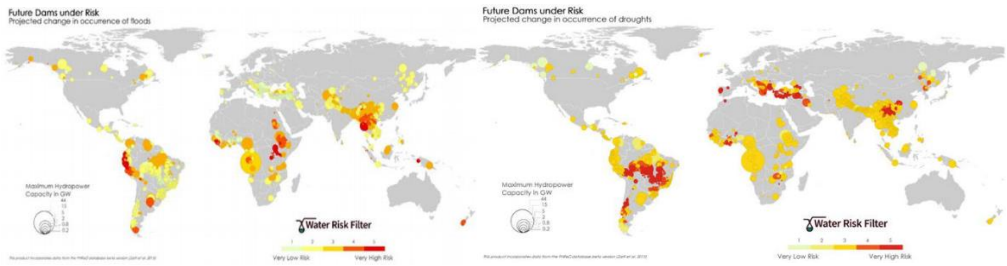

Figure 1. Future Dams under Risk from Projected Floods and Droughts

The technological innovation in the energy sector, as International Renewable Energy Agency (IRENA) has explored, goes through two energy development options to the year 2050 as part of the 2019 edition of its global energy transformation report, and aligned within the envelope of scenarios presented in the 2018 report of the Intergovernmental Panel on Climate Change (IPCC) [2]. the report outlines the role of solar photovoltaic (pv) power in the transformation of the global energy system based on IRENA's climate-resilient pathway that would be needed in the next three decades to achieve the Paris climate goals.

The International Energy Agency report "Hydropower Special Market Report Analysis and forecast to 2030" published in 2021, mentioned that prior to the massive cost declines of solar PV and wind, hydropower was the most competitive renewable electricity source globally for decades. After the 7th World Hydropower Congress in Paris, the report was dedicated to be a strong voice for the hydropower community, notably by making hydropower the focus of our Renewables 2020 market report [3]. This report was followed by "Net Zero by 2050 A Roadmap for the Global Energy Sector" from the same agency stated "Ever-cheaper renewable energy technologies give electricity the edge in the race to zero. Our pathway calls for scaling up solar and wind rapidly this decade [4], reaching annual additions of 630 gigawatts (GW) of solar photovoltaics (PV) and 390 GW of wind by 2030, four-times the record levels set in 2020". For solar PV, this is equivalent to installing the world's current largest solar park roughly every day. Same agency changed targets from hydropower to PV and wind.

The long-term picture that emerges from different projections contains a significant number of significant uncertainties. These are in particular related to two major issues: water and energy security and the geopolitical outlook on the one hand, and environmental impacts and policies on the other. Important difficulties might surround key aspects of demand projections, future patterns of demand in different parts of the world and in river basin

countries, and the question of increasing water and energy management efficiency over and above past achievements.

Other uncertainties surround key assumptions of strategic scenarios. Therefore, hydropower generation must be assessed as an option with a photovoltaic and wind power generation in a nexus context. Hydropower are not free from the adverse of environmental effects witnessing biodiversity being destroyed and disappearing in the dam reservoir area [5]. It must give loud alters around the hydropower projects and its surroundings.

This paper highlighted that global goals were not met in the context of examples of some non-scientific conflicting political and economic pathways of countries separating energy from its interlinkages and impacts on water and environment specifically in shared river basin. The paper perspective presented that large dams hydropower generation projects will not support sustainability measures in meeting the energy sector future requirements specifically with its costs, time span, and negative impacts on environmental stability, sustainability and livelihood in general and in shared river basins in specific. It also, will not support achieving sustainable development goals at global or national scales with its attached climate change risks.

At Global and national levels, it is needed to start thinking about the water, energy, and food governance not as three different sectors but as a nexus, in which multiple layers' account for the different scales, levels, and sectors. Nexus sectoral integration and institutional cooperation analysis that associated with case studies become necessary to create an integrated policy assessment of the cases under consideration. For example, energy production through water appropriation highlights local–regional–national–transnational tradeoffs, in which water, energy, food, and livelihood costs and benefits are inequitably treated. Also, there is a need to consciously develop reasonable development goals in a proper future time context balancing policy and economy with science and research.

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Circular Economy in Water Management

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Keywords: Sustainable efficient, and resilient water management, Wastewater reuse, Resilient water management, and sustainable development, Sustainable water management in the context of circular economy

CWW2023 Theme: 3

ABSTRACT

Egypt faces the challenge of improving water use productivity and sustainability. Integrated efficient water resources demand management for sustainable development has been a major trend to meet the increased water demand caused by climate change, rapid population namely, at 2% rate per year and urbanization. The main objective of the manuscript is to underline the urgent need for upscaling demand management and improve loss reduction in water and power sectors. This is not only to reduce the gap between limited freshwater resources and water demand but also safeguard to climate change challenges and its impact on / relation with selected technologies supporting circular economy and resilience.

The main issue of water resources sector in Egypt is how effectively utilizes the limited water sources. The available water resources required to meet water demand both in term of quantity and quality has been reassessed. The concept mainly addresses two approaches: “Water resources diversifications” and “making better use of existing resources.” Reuse of drainage water/treated wastewater falls under the latter approach and is considered as one of the measures to accelerate effective and sustainable use of existing resources.

It is important to promote wastewater reuse in combination with technological advances in hardware and software aspects. These innovations might be related with facility and equipment installation, institutional improvement, and environmental awareness creation through the concept of community participation leading to different levels of community empowerment and establishing a sense of ownership.

The procedures and methodology applied would include: data collection, water samples analysis, farmers’ household surveys, selection of pilot area for demonstration and experts’ consultation.

Establishment of Irrigation Complex as the measures for the conservation of drainage water quality and for the promotion of drainage water reuse in rural areas classified from the upstream-downstream point of view namely the "Water quality control," "Water treatment," and "Water reuse." Through the following:

- Rural Sewerage System (for population of 500 -1000 Capita) that plays a vital role in water quality conservation powered by renewable energy to generate electricity led to sustainability of energy use at WWTPs (Wastewater Treatment Plants) and reducing the cost of energy supply (3,000 - 5,000 KWH a year). Placing the WWTPs

underground of public lands such as drain slopes and rural roads along the drain solved the issue of land scarcity. This method is suitable for rural areas in Egypt where population growth has been prevailing.

- In-stream Wetland Treatment Facility is planned inside the drain to improve the DO (Dissolved Oxygen) and COD (Chemical Oxygen Demand) values of drainage water quality. The facility consists of a sedimentation zone, vegetation zone, transition zone, and aerating zone with plastic contact media.
- Agricultural Compost Facility is planned to prevent sludge, animal feces and crop residues from being dumped into the drain and also to prevent the materials coming from those waste infiltrating to underground through co-composting of sludge with solid waste and utilized as a fertilizer.

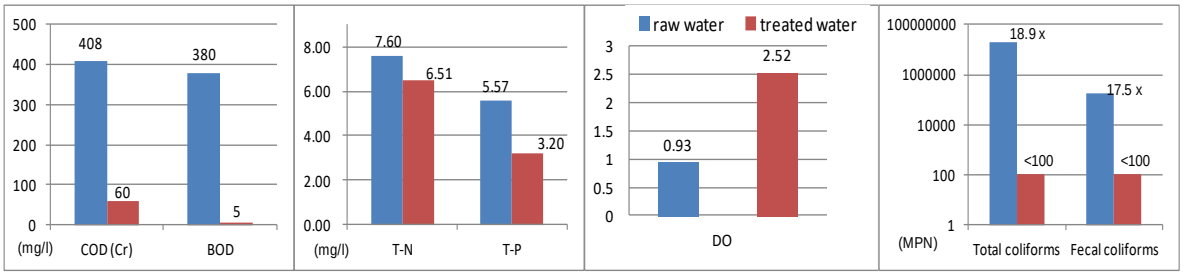

Figure 1: Comparison of water quality before/after the treatment (Rural sewerage treatment facility) in Sandala Village in Kafr Elshiekh Gov

Drainage Water Reuse Pump: This pump is used to promote the reuse of drainage water with improved water quality."

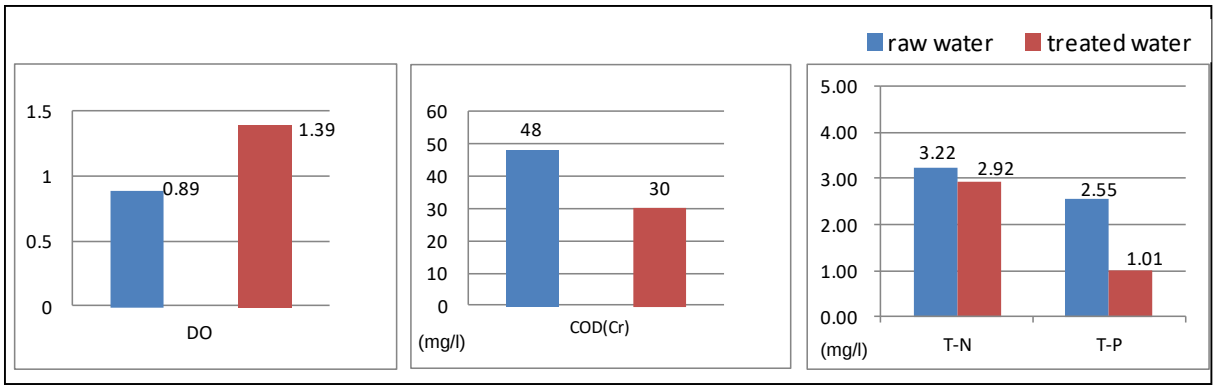

Figure 2: Comparison of water quality before/after the treatment (In-stream Wetland Treatment facility) in Sandala drain in Kafr Elshiekh Gov.

It could be concluded from previous analysis that there is an urgent need to improve water management, sludge management and utilization in a more sustainable manner, inclusive, efficient, resilient way and develop viable solutions for water saving under 3Rs: reduce, reuse, and retain water in the country. Also, Wastewater Treatment Plants (WWTPs) should be considered as water resource recovery facilities (WRRFs). WRRFs can directly change the concept of treatment to management and contribute to create a circular economy in the best management practices. This would achieve best outcomes in terms of wastewater system sustainability by producing clean water, nutrients, renewable energy, and other valuable bio-based materials from wastewater as the treatment effect observed at the WRRF, COD and BOD removal ratios were 85 % and 99 % , In terms of the nitrogen and phosphorus compounds, removal ratios were confirmed 14% and 43% respectively, fully complied with the drainage water quality standards, which indicates that treated water has fairly good

quality, led to increase available drainage water for irrigation, increase of crop productivity by (8% - 23%), reduction of chemical fertilizers (2%-6%) in the value of nutrients: 1.62kg/fed – 4.76kg/fed, saving fertilizer cost , in addition to powering this facility by renewable energy led to reducing the cost of energy supply (3,000 - 5,000 KWH a year, which contribute on water shortage mitigation by 28%.

The recommendations derived to provide a blueprint for Egypt to address its water resource challenges effectively and adapt to the changing landscape of water demand and climate change impacts.

Acknowledgment

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Isolation and Identification of Multi Azo Dyes-Degrading Bacteria and Optimization of the Decolorization Conditions

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Keywords: Azo dyes, biodegradation, wastewater, biofilter, *B. coagulans, L. macrolides*
CWW2023 Theme: 3

ABSTRACT

With the increase of world population, the water resources become a serious problem. Large volumes of industrial wastewater are drained daily. This wastewater can be treated and recycled, that saves apart of the used fresh water in some industries. The textile industrial wastewater often contains residual azo dyes that have serious risk to human health as well as the plant and soil microorganisms. The biological treatment of these wastewaters is the most save and cost effective approach. This study aims at isolation and identification of multi azo dyes-degrading bacteria and optimization of the biodegradation conditions.

Twelve azo dyes-decolorizing bacterial isolates were isolated from soil, water and wastewater samples [1]. These isolates were identified by the 16srRNA gene sequencing technique (**Figure 1**). Capacity of these bacteria to decolorize twenty azo dyes was investigated.

The identified bacterial strains were tested for decolorization of twenty azo dyes **(Table 1)**. The most sensitive azo dye for bacterial decolorization was direct violet, where the decolorization percentage ranged from 38.5 % by *K. pneumoniae* to 82.6% by *L. macrolides* and *B. subtilis.*

The most effective five bacterial strains namely, *B. brevis, B. coagulans, L. macrolides, L. fusiformis* and *B. subtilis*, were subjected to study the effect of some nutritional factors including glucose concentration, organic nitrogen source supplementation and microelements solution concentration on the decolorization capacity, biomass, lignin peroxidase [2], laccases [3] and azoreductases production [4] in Mineral Salt Medium (MSM) supplemented with either direct violet or methyl red azo dyes as sole carbon sources. The tested nutritional factors showed variable effects on the tested bacteria regarding their decolorization efficiency, biomass and enzymes production.

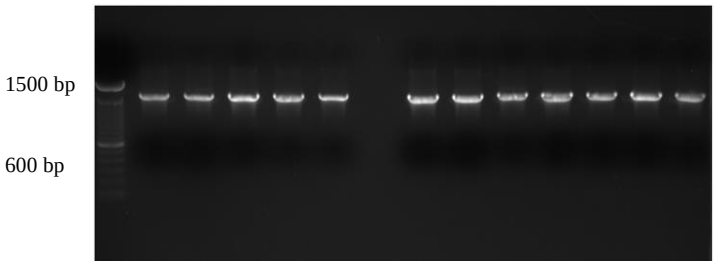

Figure 1: The agarose gel separation of the 16S-rRNA genes of twelve bacterial isolates.

This study suggests the use of *B. coagulans* and *L. macrolides* in a biofilter for biodegradation of azo dyes, where it showed the highest decolorization percentages for a large number of azo dyes, as well as the highest enzymes production among the tested bacteria.

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Table 1: The decolorization % of twenty azo-dyes by the isolated twelve bacterial isolates

Bacterial isolate	Alirazin yellow	Alura red	Brilliant green	Crystal violet	Direct blue	Direct red	Direct violet	Evans blue	Fast green	Janus green	Methyl red	Naphthol blue	Para-rosani-line	Ponceau	Reactive blue	Reactive orange	Reactive red	Safranin	Tartrazin	Trypan blue
L. fusiformis	8.11	3.86	12.99	7.28	4.41	10.84	53.95	1.33	17.94	4.28	4.21	1.18	13.92	3.45	23.04	12.03	13.93	0.76	0.85	6.78
B. parabrevis	5.11	0.65	25.69	7.28	3.46	9.22	50.03	1.51	13.84	3.14	0.95	7.67	7.10	3.24	11.17	11.37	23.92	4.98	0.26	9.78
S. epidermidis	4.41	3.64	13.24	8.62	5.56	6.31	75.23	1.16	9.73	7.71	0.81	8.38	13.64	7.70	11.55	10.50	10.91	0.67	0.18	10.29
B. melitensis	4.44	4.19	43.97	9.09	2.98	7.34	61.30	1.38	5.88	4.85	0.37	4.92	27.29	6.90	0.41	10.34	6.52	3.64	-0.35	11.00
B. cereus	1.38	5.30	3.54	8.88	5.38	7.85	58.39	1.83	9.55	1.34	3.80	5.86	19.81	8.75	11.44	9.08	6.92	0.77	0.94	10.66
L. macrolides	2.47	7.27	0.45	7.19	4.91	3.65	82.61	2.81	9.29	4.79	2.97	13.18	21.03	2.62	18.08	8.37	16.47	2.71	-0.16	15.02
B. coagulans	2.61	3.26	0.60	4.19	0.31	3.39	81.75	1.59	14.34	3.66	-0.19	11.24	44.65	7.47	20.47	10.71	13.70	2.18	0.35	14.00
S. aureus	2.18	3.31	8.22	2.56	2.32	0.33	60.85	2.02	9.51	0.85	4.54	8.17	10.08	13.47	22.02	12.50	13.50	-0.10	12.29	13.67
B. subtilis	2.46	1.90	5.35	2.26	3.90	0.17	82.66	1.59	9.50	0.01	-0.24	7.85	6.56	13.20	16.53	8.92	12.17	4.94	11.80	14.09
B. brevis	1.71	0.47	4.95	2.26	4.32	6.77	80.30	1.51	8.73	0.01	1.73	7.52	5.94	14.80	9.89	10.19	12.35	-0.04	11.66	10.79
L. xylanilyticus	1.89	3.29	19.77	1.35	2.58	-0.05	70.01	2.01	5.60	0.28	0.66	10.23	6.36	14.29	10.62	4.58	10.68	0.54	11.48	11.27
K. pneumoniae	2.69	2.25	14.83	0.41	0.00	0.36	38.50	3.52	4.00	0.01	0.50	7.52	5.54	15.47	0.48	1.02	18.82	-0.09	10.64	9.15

Integrated Water and Sanitation Safety Planning for Small Communities in Jordan: The Case Study of Princess Eman Housing

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Keywords: Drinking water, integrated approach, risk management, sanitation safety, small community, water safety
CWW2023 Theme: 3

ABSTRACT

Water and sanitation are crucial factors for health. Therefore, maintaining safe water supply and proper sanitation are substantial for improving public health. In order to ensure sustainable and safe drinking water supply and hygienic sanitation services, WHO recommends the use of risk management approaches through its tools; the Water Safety Plan (WSP) [1] and the Sanitation Safety Plan (SSP) [2]. Those tools provide practical step-by-step guidance to assess, monitor and manage water and sanitation risks from source to end user. In a context with limited resources and administration support, where water and sanitation systems are considerably interlinked, it is unlikely to run WSPs and SSPs separately and an integrated water and sanitation safety planning (iWSSP) is a desirable approach and more likely to be done. This study aimed at applying the iWSSP approach to a small community in Jordan.

The development of the iWSSP approach for the Princess Eman housing was carried out through running a holistic integrated system description and risk management of the water supply system and the sanitation chain. The steps of iWSSP are listed in the table (1). Existing government frameworks and regulations within the water and sanitation sector were studied. The methods used for data collection were household survey, key informant interviews with the concerned national stakeholders and field investigation for the pilot site. The household survey consisted of 11 general and 64 technical questions covering water, sanitation, hygiene and health aspects, including a water quality testing component. The problem-centered interviews were used. The interviews' questions ranged between 5-15 questions for each stakeholder as per its involvement.

Table 1. The integrated Water and Sanitation Safety Plan Steps

Step 1 – Prepare for iWSSP
Define the objectives and scope of the iWSSP, identify stakeholders and assemble a team
Step 2 – Describe the water supply and sanitation system
Accurately describe the water supply and sanitation system and compare with real situation through site visits and field investigations
Step 3 – Hazard identification and risk assessment
Identify hazards and hazardous events, and assess the risks
Step 4 – Define control measures and develop and implement an incremental improvement plan
Define control measures and develop a detailed improvement plan to address all significant risks requiring additional control
Step 5 – Monitor control measures and verify the effectiveness of the iWSSP
Define an operational monitoring plan for important control measures and obtain evidence that the iWSSP as a whole is working effectively
Step 6 – Develop supporting programmes and review plans
Develop and implement supporting programmes and periodically review and update the iWSSP

The iWSSP of the Princess Eman housing emanated 19 hazards and hazardous events. Those were assessed and prioritized using semi-quantitative risk assessment, as summarized in Annex (1). An improvement plan was developed and modified based on the feedback received by the concerned stakeholders. The financial and institutional challenges were the impeding factor of implementing the improvement plan, including solving the issue of the out-of-service wastewater package plant.

The thesis results addressed the current water and sanitation risks at the Princess Eman housing. A communication gap was very vivid between the concerned stakeholders when the wastewater package plant was constructed. More work is required such as studying the water pressure and reviewing the design of the internal sewer network to further assist the stakeholders and to find a common ground to agree on implementing the remedial actions.

Acknowledgment

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Annex 1. Semi-quantitative risk assessment of the identified hazardous events at Princess Eman housing

No.	Hazard / Hazardous event	Likelihood (L)	Severity (S)	Score	Risk rating	Basis
1	Insufficient amounts of water are received by households living at or near the highest area within the housing	5	8	40	Very high risk	L – 5: happens every water cycle (exacerbates during summer season) S – 8: resulting in illness
2	Loss of water due to leakages around water meters	5	8	40	Very high risk	L – 5 – occurs every water cycle S – 8 – major water loss
3	Loss of water due to leakages in rooftop tanks	4	4	16	High risk	L – 4 – occurs every water cycle S – 8 – minor water loss
4	Loss of water due to non-functioning floating valves in rooftop water tanks	3	8	24	High risk	L – 3 – may occur S – 8 – major water loss
5	Loss of water due to water theft from water meters of the non-occupied households	3	8	24	High risk	L – 3 – may occur S – 8 – major water loss
6	Water tanks are not regularly cleaned and kept open or not well-covered	4	4	16	High risk	L – 4 – observed and is likely to occur S – 4 – minor illness
7	High levels of TDS in water filters due to unmaintained filters on regular basis (every 6 months)	3	2	6	Low risk	L – 3 – may occur S – 2 – minor health effects
8	Rodents and weasels come out of the floor drains for households living at or near the lowest area of the housing	4	8	32	High risk	L – 4 – likely to occur (exacerbates during summer season) S – 8 – resulting in illness
9	Wastewater backflow in basement houses in buildings near the wastewater package plant, inside their apartments and backyards	4	16	64	Very high risk	L – 4 – likely to occur S – 16 – serious illness
10	Direct connection from buildings experienced	4	8	32	High risk	L – 4 – observed

No.	Hazard / Hazardous event	Likelihood (L)	Severity (S)	Score	Risk rating	Basis
	wastewater backflow to the WW package plant (risk of cross connection)					S – 8 – may lead to serious contamination
11	Water stagnation as a result of clogged floor drains at rooftops	3	1	3	Low risk	L – 3 – may occur S – 1 – negligible health effects
12	Households get skin allergy from insects, lungs allergy and tissue inflammation from bad odors	4	4	16	High risk	L – 4 – likely to occur (exacerbates during summer season) S – 4 – resulted in illness
13	Vacuum trucks, when entering the housing, are risky to the community, especially the school pupils, given the narrow streets	5	16	80	Very high risk	L – 5 – certainly occur S – 16 – may result in loss of life
14	Vacuum trucks cannot enter the housing during very cold days or snowy weather; hence the wastewater level increases, and wastewater is diverted into the aeration tanks	2	4	8	Medium risk	L – 2 – occurs in exceptional circumstances S – 4 – potentially resulting in illness
15	Vacuum truck drivers do not wear full PPE	5	2	10	Medium risk	L – 5 – occurs every emptying process S – 2 – minor health effects
16	Wastewater residues on streets after the emptying process	5	2	10	Medium risk	L – 5 – occurs every emptying process S – 2 – minor health effects
17	The 9 m^3 tank in the WW package plant has only one working pump (standby pump is broken)	4	16	64	Very high risk	L – 4 – likely to occur S – 16 – potentially resulting in illness
18	The WW package plant is vulnerable to floods and easily accessible by animals (spread diseases) due to low fence and existing cracks	3	2	6	Low risk	L – 3 – may occur S – 2 – minor exposure

No.	Hazard / Hazardous event	Likelihood (L)	Severity (S)	Score	Risk rating	Basis
19	Solid wastes are not collected regularly by the municipality staff	4	2	8	Medium risk	L – 4 – occurs regularly S – 2 – minor exposure
Note: The **e**xposure group for all identified hazardous events is the local community of Princess Eman housing, except number 15, the exposure group is the workers or drivers of the vacuum trucks.						

Theme 4: Improving Early Warning Systems for Severe Weather Events and Prolonged Droughts

Spatial and temporal analysis of meteorological drought variability in the Coastal Region in Syria during 1983–2017

Hiba Mohammad, Reem Mansour, Lilina Freitas, Helder I. Chaminé

Harnessing Satellite services to reduce flood risk

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Intensity-Duration-Frequency Curves for Hydrologic Design in Egypt Based on Combined Ground Station and Remote-sensing Data

Mohamed Saad, Yehya Imam, Hesham Bekheit

Mitigating Flash Floods and Urban Floods: A Pragmatic Approach to Implementing A Flood Early Warning System in Nigeria

Emmanuel Thomas, Adeniyi S. Gbadegesin

A road map for Alexandria against drown possibility as a result of climate change and sea level rise

Ayman El-Gamal

Dominant Flow Driving Mechanics at Different Temporal Scales along the Gulf of Aqaba

Ramy Marmoush, Dina H. Elbagoury, Omar A. Nemr, Omar M. Mohamed, Mohamed S. Oraby

Spatial and Temporal Analysis of Meteorological Drought Variability in The Coastal Region in Syria during 1983–2017

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Keywords: Crop yield; meteorological drought; SPI; IWRM, Syria.
CWW2023 Theme: 4

ABSTRACT

Drought is one of the natural hazards that has negatively affected the agricultural sector worldwide. The Mediterranean (MED) region is recognized as a highly reactive area within the climate system when confronted with heightened aridity resulting from global warming exceeding 1.5°C [1]. Syria, being a Mediterranean country, ranks third among the nine nations that are deemed to be at a "very high risk" of experiencing drought [2]. According to reports, the drought that occurred between 1998 and 2001 in the Eastern Mediterranean was deemed the most severe in half a century, resulting in the impact on millions of individuals [3]. Moreover, the 2007-2010 drought was described as the most severe drought in the instrumental period [4]. This study aimed at tracking drought characteristics (frequency, intensity, and spatial extent) in the Coastal Basin of Syria between 1983 and 2017 and evaluating their impact on olive production.

Rainfall data on an annual basis were collected from five meteorological stations covering the period between 1983 and 2017. The source of the data was the Ministry of Agriculture (MoA) in Syria. The evaluation of data completeness, quality, and homogeneity across all stations was conducted with great attention to detail, adhering to the guidelines established by the World Meteorological Organization [5]. The current study utilized the Standardized Precipitation Index (SPI) as proposed by Mackee *et.al.* (1993) and endorsed by the World Meteorological Organization (WMO) for evaluating meteorological drought [7]. In this study, the Gamma distribution was employed to transform precipitation data into standardized series that exhibit a mean of zero and a variance of one. The categorization of the values of the SPI into distinct classes was accomplished through the utilization of Agnew's (2000) scheme [8]. The trend was evaluated using the non-parametric Mann–Kendall (M–K) test. Olive yield data was collected from The Food and Agriculture Organization (FAO) database. Pearson correlation was used to investigate the relation between drought conditions and olive production in the region with a confidence level of 95%.

The regional series of Standardized Precipitation Index (SPI) at a 12-month timescale is depicted in Figure 1. The region experienced extended periods of dryness, notably from 1989 to 1991, 1993 to 1995, and 1997 to 2001. Notably, there was a significant increase in drought severity in 2014 and 2016 compared to other dry years. Within the timeframe spanning from 1983 to 2017, there were four years characterized by moderate drought conditions, while severe

drought conditions were observed for a single year and an extremely dry spell was observed for another year. In contrast, there was a higher frequency of moist occurrences observed from 2002 to 2004, as well as from 2011 to 2013. Moreover, no trend was present at the regional scale.

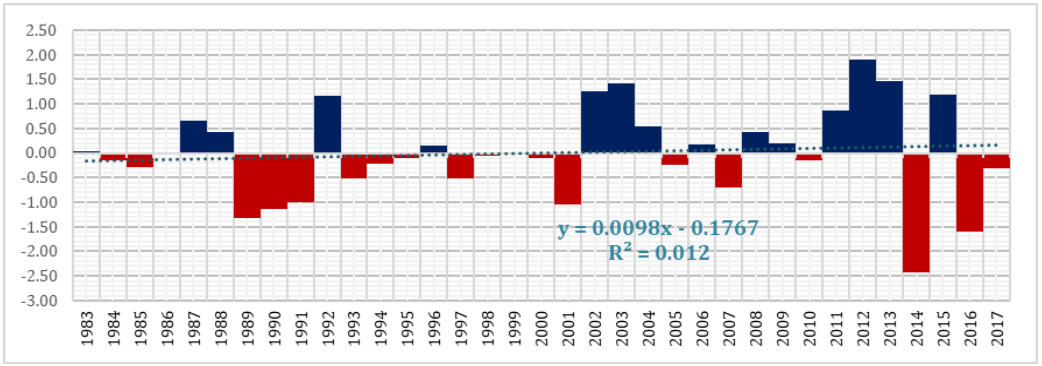

Figure 1. Temporal evolution of the SPI values at 12-month timescale.

The Pearson correlation coefficient between the crop yield and the SPI drought indicator is 0.51, indicating a moderate positive correlation. Figure 2 shows the yield distributions of olive crops under different drought conditions based on SPI. The blue boxes represent the yield distribution in years with wet/normal index values (greater than -0.5), while the orange boxes represent the distribution in years with dry index values (less than -0.5). This representation highlights the influence of drought conditions on the yield of olive crops.

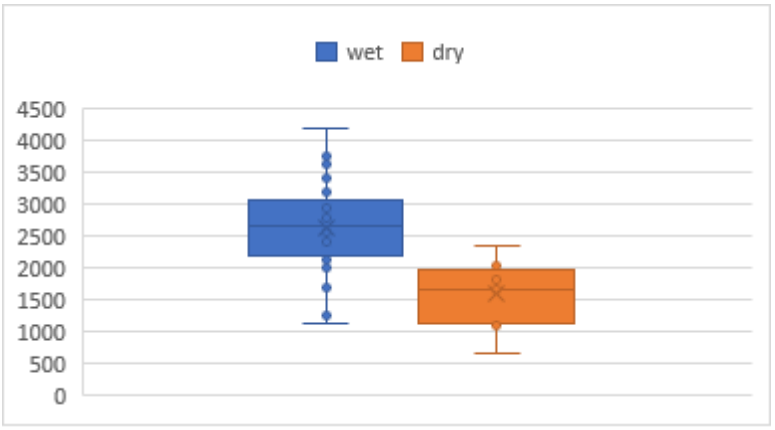

Figure 2. Olive yield distribution in wet (normal) conditions and dry conditions

The analysis of drought suggests that the Mediterranean Coastal Area of Syria went through one of the worst dry spells in the country's history in the 1990s. In addition, the drought episode from 2007 to 2010, which was the worst 3-year drought in the instrumental period, had also it impact on the region. Overall, the increase in frequency and severity of droughts have devastating effects on the agricultural sector in Syria, with grave consequences for crop productivity. Olive crop yield declined during dry spells compared to larger production during the favorable wet episodes.

In addition, the reported results indicate that the approach used in this research can be utilized to monitor drought conditions in Syria successfully. This approach is a balanced solution to monitoring and sustainable design for climate change. This is relevant as a drought early warning system, drought management plans, and long-term strategies for integrated water resource management (IWRM) are all essential to ensuring the long-term success of our economy, society, and environment.

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Harnessing Satellite services to reduce flood risk – WMO's contribution

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Keywords: Flood, Satellite, Disaster Risk Reduction
CWW2023 Theme: 4

ABSTRACT

On average over the past 50 years (1970-2019) a disaster related to a weather, climate or water hazard has occurred every day, with roughly 120 fatalities and costing more than US$200 million in losses daily. In addition, the number of weather and climate related disasters increased by a factor of five over the 50-year period, driven by anthropogenic climate change causing more extreme weather events and improved reporting. However, due to improved monitoring by satellites and more extensive ground-based sensors, there has been a dramatic improvement in early warnings and disaster management leading to a three-fold decrease in the number of fatalities over the same period. All of these facts demonstrate the critical link between weather, climate and water events and disaster management, and highlight some of the fruits of the long-standing relationship between the hydro-meteorological and disaster risk management communities.

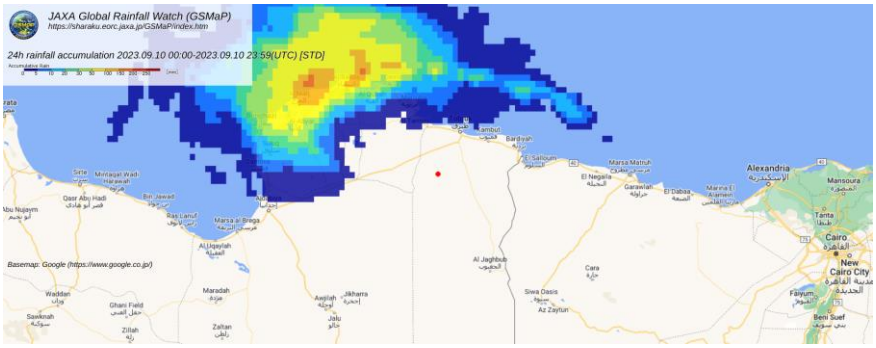
Providing critical satellite data and products covering many application areas like flood monitoring and satellite-based precipitation is critical to disaster response, especially in remote regions and in developing nations where ground based observation is limited. The WMO Integrated Global Observing System Vision for 2040 (WIGOS2040) provides a forward-looking view of space-based capabilities required in the future for Earth Observation, including support to disaster risk management. Space Agencies respond to WIGOS2040 and coordinate their observations through the Coordination Group for Meteorological Satellites (CGMS) and the Committee on Earth Observation Satellites (CEOS).

Soil moisture is important in the forecasting and monitoring of drought conditions as well as helping forecast areas where wildfires are likely to occur as well as helping indicate where impending drought or flood conditions are before an actual flood event. Owing to the scale of countries, remote sensing is the most effective way to cover large areas and gauge trends over a long period of time to get an accurate picture of how moist a region is. This can then help determine how susceptible it is to flooding. There are several satellite-based soil moisture products that are available from active and passive microwave instruments, scatterometers (ex. Advanced Scatterometer, ASCAT. Wagner et al., 2013) and imagers (ex. VIIRS) on polar orbiting satellites.

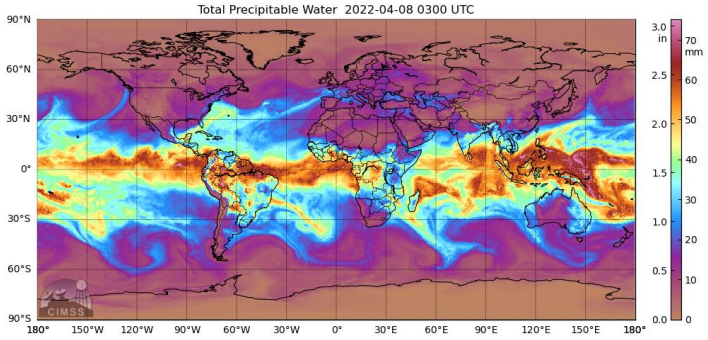
At the beginning of a flood event, information regarding precipitation rates can be extremely useful, especially for flash flood warnings. The best source of this information comes from ground-based weather radars. However, there are major gaps in radar data, especially in developing countries, and do not provide an indication of what is happening beyond the range

of the radar. Satellite precipitation estimates such as CMORPH2 (Xie et al, 2022) and GSMaP (Aonashi et al, 2009), shown below and available to view at:

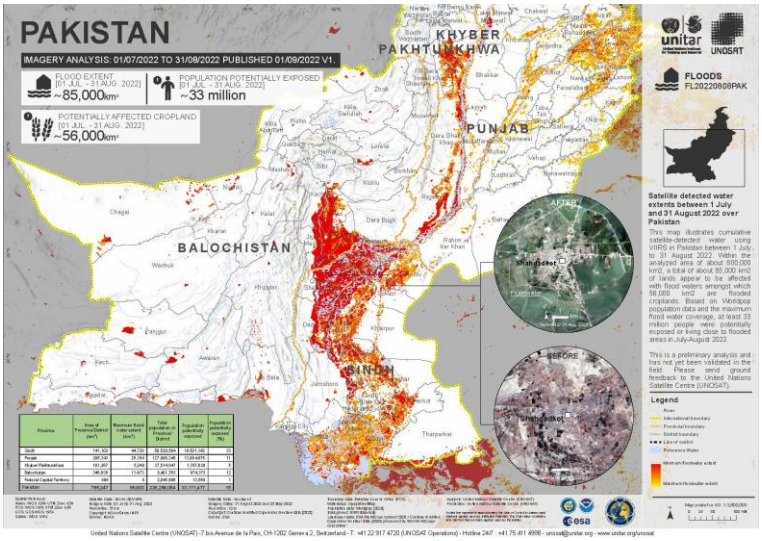
https://sharaku.eorc.jaxa.jp/GSMaP/index.htm, while coarse in resolution with limited temporal resolution, can provide a longer lead time in knowing what may impact a given area.



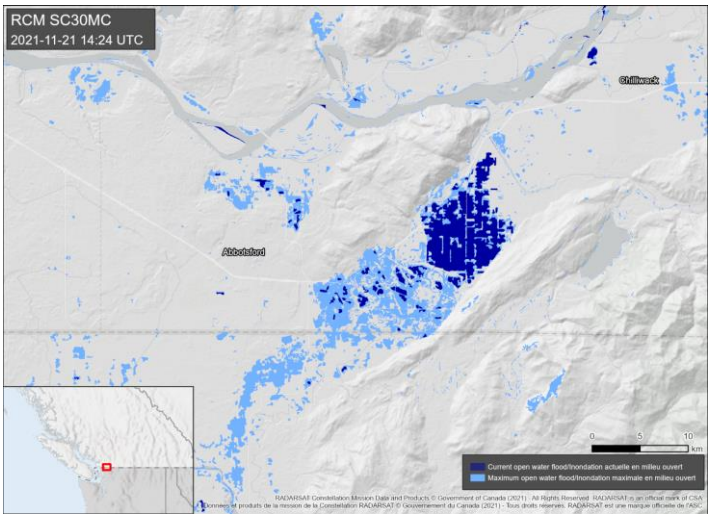
These can also be combined with information from satellite microwave derived total precipitation estimates, such as MIMIC-TPW (Wimmers and Velden, 2010), shown below, can provide a several days warning of heavy precipitation events, such as atmospheric river events which can lead to catastrophic flooding along coastal regions (Dettinger et. al, 2011).



Historically, flood monitoring has relied on ground based observations such as river gauges, and the occasional aerial reconnaissance from piloted aircraft or, more recently, unmanned systems (UxS's) or field reports from observers (i.e. citizen scientists). However, these types of observations are limited in scope as they are focused right along the river itself and may take a while to be reported. Recently, the usage of satellites to perform flood detection has become widely used (Schumann et al., 2009; Revilla-Romero et al., 2015, Li et al., 2018), especially in helping evaluate flooding in remote areas and for rapid disaster response. For example, the Federal Emergency Management Agency in the United States, as well as international agencies utilize satellite derived flood extents to derive impacts from severe flooding events occurring worldwide. Another good example is the United Nations, which as a part of The International Charter Space and Major Disasters, uses flood extent data from satellites to look at socio-economic impacts, shown below for an example from the large-scale floods in Pakistan in 2022.



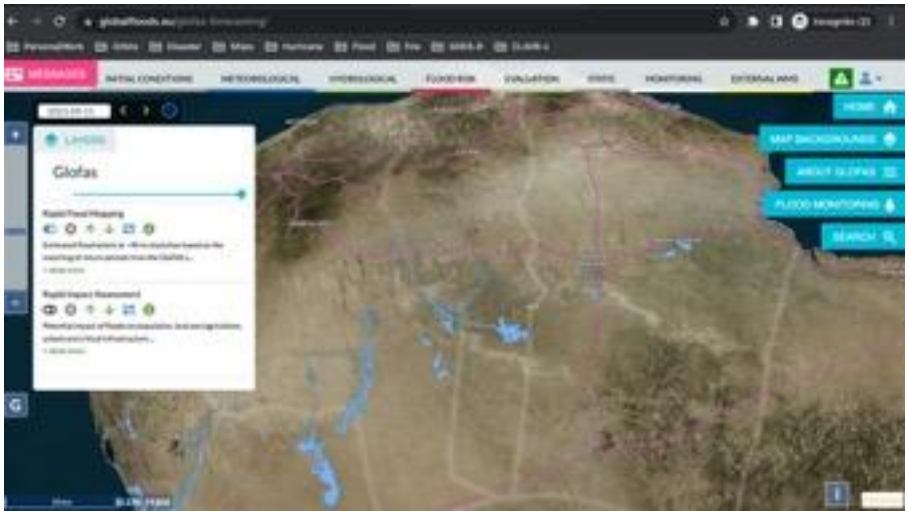
There are a wide variety of satellite derived flood products from both optical instruments as well as Synthetic-aperture radar (SAR) imagery. While more temporally available, optical flood products from meteorological satellites (ex. Huang et al., 2018; Li et al., 2018) are at relatively coarse spatial resolution. To some extent this can be alleviated by downscaling the data by utilizing digital elevation models (Li et al, 2013) or by using a higher resolution polar sensor (ex. Sentinel-2 or Landsat). The usage of SAR imagery can be used to generate flood products, such as Canada's Radar Constellation Mission (RCM), which is shown below.



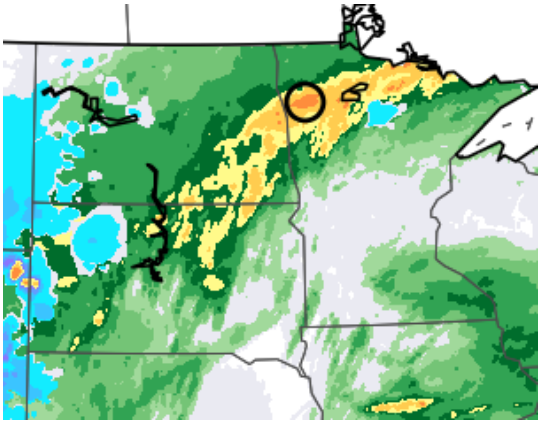
Most of these products are "on demand", which means that they are not necessarily automatically produced on a routine basis and not necessarily routinely and freely available to all users. In addition, there is a relatively low repeat cycle, even for RCM, for SAR data.

While radar and satellite-based precipitation measurements are important now-casting tools, one does need to model how the precipitation will affect river levels to provide a tool to help issue timely warnings. There are a variety of models across the world, ranging from world-wide models such as Global Flood Awareness System (GloFAS, Alfieri et al, 2013; Harrigan et. al, 2020), developed by Copernicus, to models that are developed to a specific country, such as the National Water Model (Gochis et al., 2020) developed by the United States National Weather Service (NWS). The major limitation of these models is that they rely solely on satellite derived soil moisture and modeled precipitation as input, rather than estimates from

rainfall and precipitation from radars and satellites and do not utilize any flood monitoring (ground or satellite) data as inputs. However, such information is used for validation of the output from the flood models. An screenshot of the GloFAS website (https://www.globalfloods.eu/) showing the modeled output of the catastrophic flood in Libya in September 2023 is shown below



Utilizing all of the types of products were demonstrated during the historic flooding of the Red River in 2022 and the normal flooding during the 2023 season. The flooding was caused by a number of factors, including a dry fall, deep frozen ground, very large snow and precipitation events. During the flood event a wide range of remote sensing was used to observe the impacts of flood events including radar data, flood gauges and satellite imagery to provide decision support. For example, the total measured precipitation as measured from radar is shown below, which helps determine where the greatest impact might occur.



Satellite imagery was able to help determine the location of the source of water that was causing mysterious flooding by overlaying it on a 3D map. This type of satellite analysis can be done on the Sentinel Hub (sentinel-hub.com) website

There are still several major gaps and impediments over a wide range of types and origin in the access to Earth observation data, specifically as it relates to the response to disasters and disaster risk management (CEOS-WGDisasters, 2020). These include national and institutional policies which constrain the exchange of data or restrict the sharing of data, either in resolution or real time data availability, lack of coverage of ground-based gauge or weather radar information to help complement and validate remotely sensed flood extents and the ability for developing nations to have sustained and cost-effective satellite-based dissemination systems in order to receive earth observation data. The largest gap is the need to provide the critical set of skills or services as it relates to how to acquire, analyze and utilize the various satellite and model data as it relates to flood forecasting and response. The largest issue is that there is no "generalized" training. Groups such as Virtual Laboratory for Training and Education in Satellite Meteorology (VLab) and the Earth Observation Training, Education, and Capacity Development Network (EOTEC-DevNet) were developed to make remote sensing capacity building more accessible and relevant in order to make it more useful in decision-making on climate change and disaster management along with the critical training needed to use those products. Both of these initiatives can help in developing capacity across developed and developing countries. An example of this was recently with the BMKG VLab Center of Excellence hosting a training specifically for the usage of the NOAA flood products, which participants from around the world participated in learning how to use flood products as part of their Impact Based Warnings and Forecast programs, aiding in ability to warn the populations earlier of impacts from flooding.

Summary

There are a large number of remote sensing products and capabilities that can be used for all stages of a flood event, ranging from determining how moist soil is, to showing how much rainfall is occurring to mapping the flood extent. In addition, some of these are utilized within flood models which can be used during the flood event for nowcast and forecasting flood impacts. However, while there are a lot of tools available, the largest hurdle is providing the right information to forecasters and stakeholders. Activities such as VLab and EOTEC DevNet are beginning to help in capacity building activities across various NMHS's and disaster and relief agencies.

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Development of a Low-Cost Smart Navigation System for Nile River in Egypt

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Keywords: GPS, Nile River, smart Navigation System; RIS, Inland Navigation
CWW2023 Theme: 4

ABSTRACT

In recent years the Government of Egypt initiated the efforts towards developing a navigation system in Nile River in Egypt. Developing Nile River navigation system depends on the availability of updated data and on-line information for Nile River depths all over the year in order to identify the best route that can be used for ships. The fluctuation of water levels through the year which cause drought and flood has a significant effect on navigation. Nile River water leve1 always changes that effect changing of Nile River depths. This point is critical and has entertained thinking about using smart technology. In terms of the significance of incorporating smart techniques into large river navigation systems to increase inland navigation competitiveness. This paper introduces a new smart and economic navigation system for Nile River in Egypt based on information and communication technologies as real-Time tracking systems for navigational depths via GPS devices attached to the navigational unit, allowing the navigational unit's skipper to identify the navigational path and safe navigable areas. The developed system is an integration of Geomatics Engineering and Software Engineering on how maps, data, functions, and information were used in a usefu1 way using programming language and Geographic Information System (GIS) to enable inland navigation operation. In addition to providing early warning of non-navigational areas, the developed smart navigational system is less expensive, as there is no need for dedicated devices to display these maps or expensive infrastructure. The developed smart navigation system has been tested and the results are presented to demonstrate its capabilities.

The study area is a part of the First reach of the Nile River in Egypt (Figure 1), which is located between Aswan High Dam and Esna Barrage, which extends from km 7 to km 169 downstream of Aswan dam with a length of about 162 km.

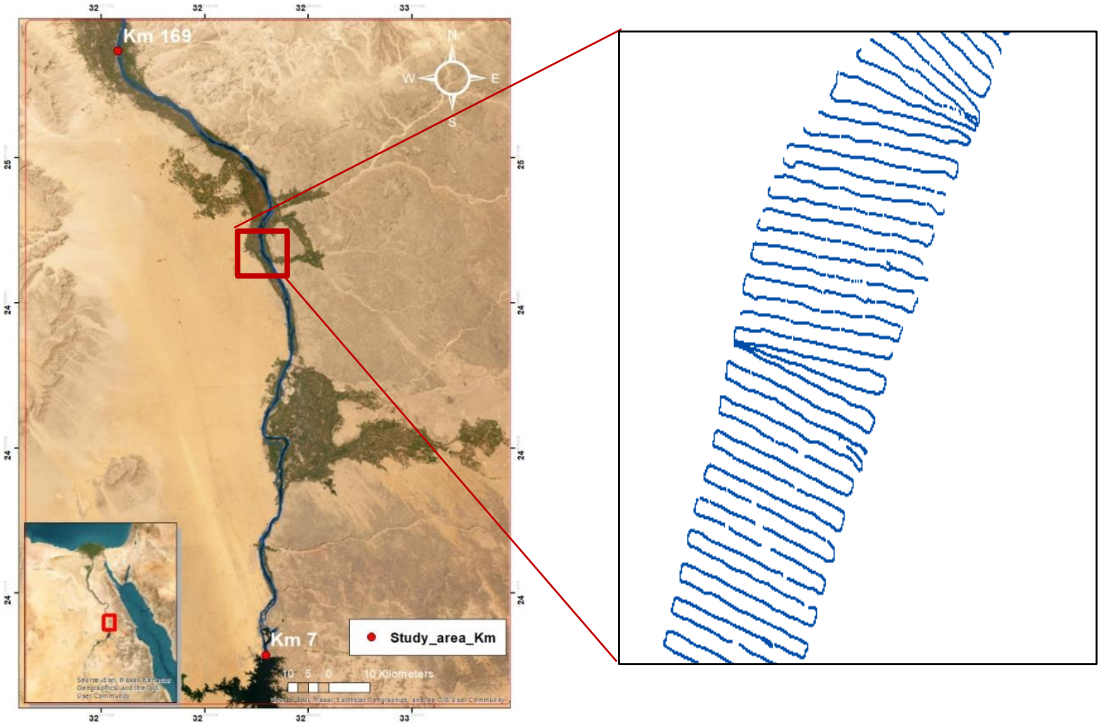

Figure 1. The study area

Throughout Egyptian history, the Nile River has been identified as a navigable channel. It stretches for about 950 kilometers from Aswan High Dam to Cairo, divided into two branches, Rosetta and Damietta, each about 200 kilometers long, and eventually reaches the Mediterranean Sea [1, 2, 3]. The Nile River's expanded fleet does not correspond to its already-existing facilities. Change in the level of the River Nile bed and continues change of the water levels; along the River Nile from Old Aswan Dam to Delta Barrages are the significance problems that face the navigation in the River Nile. Most boats start to face problems when the discharge is less than 100 million m3/day. Boats which have draft higher than 1.5 m find serious difficulties and when cruising as the flow discharge reaches 65 million m3/day. Unfortunately, the peak season for hotel boats and tourism is during the period November-February [4, 5, and 6]. The developed system aims to replace traditional navigation aids (buoys) with economic electronic navigational maps supported by the navigational path, as well as, providing real-time data for navigational depths via GPS devices attached to the navigational unit, allowing the navigational unit's skipper to identify the navigational pat and safe navigable areas. In addition to providing early warning of non-navigational areas, the developed electronic navigational maps are less expensive, as there is no need for dedicated devices to display these maps or expensive infrastructure.

Figure 2 shows the workflow of the study. In this part, the developed system inputs are prepared and the system architecture and modules are determined and deployed.

The smart navigation System for the Nile River has been developed with the intention to capture Navigation Unit location data, furthermore developing an alarm system for the dangerous zones for navigation according to NRI safe navigation path. Figure 3 shows the user interface of developed application. This developed system contains five main component modules: (i) GPS & Eco-sounder Data Capture (ii) Data processing, (iii) wireless communication network (iv) web application, and (v) Alarm System.

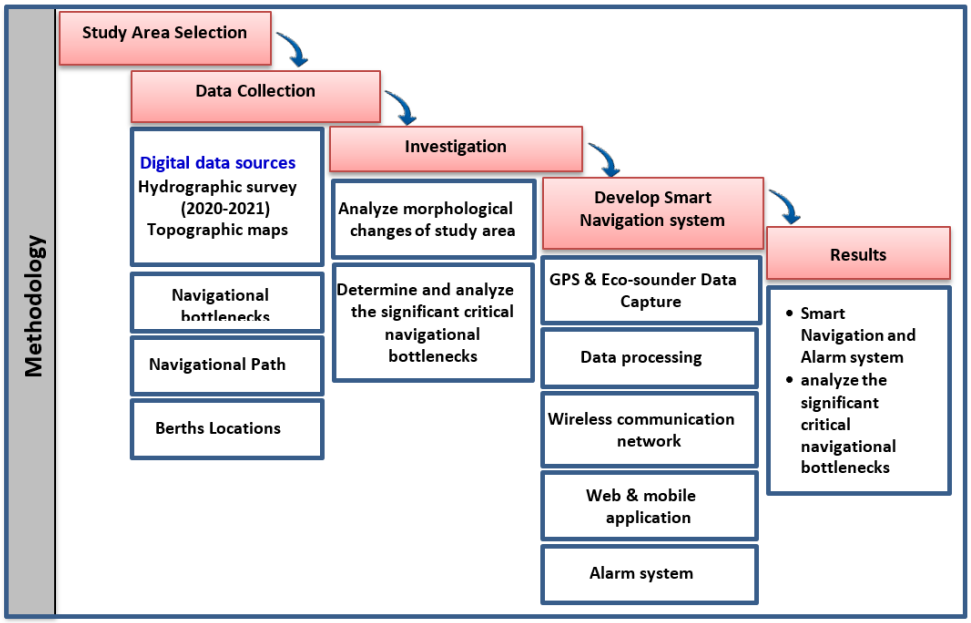

Figure 2. The Methodology Workflow

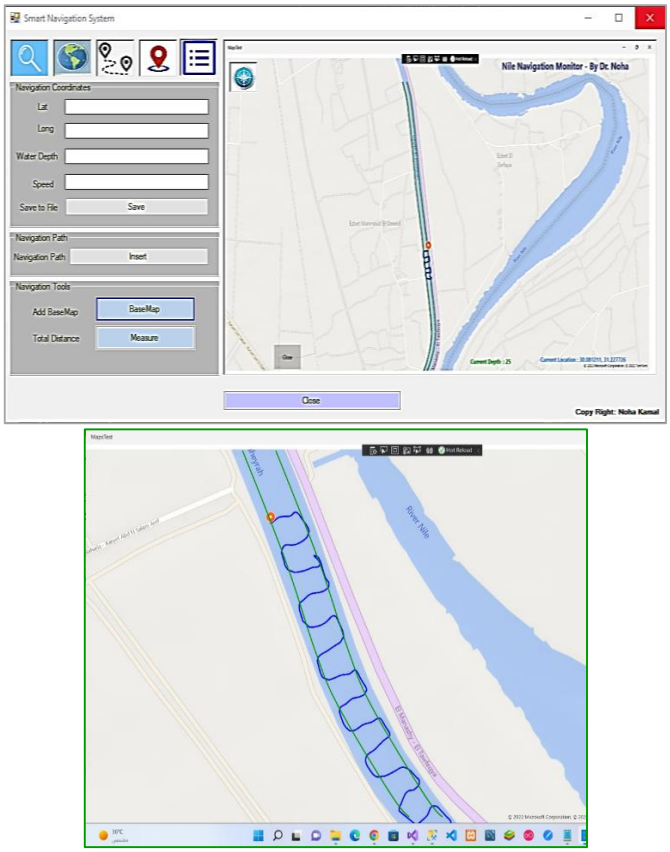

Figure 3. Smart Navigation system developed by authors

(a) The main GUI for smart navigation system (b) water depth map supported by navigational path

No doubt, the development of a smart navigation system for the Nile River in Egypt is required to update all available data for navigation units in real time in order to navigate safely through the inland waterway. Furthermore, the improvement of navigation in Nile

River will increase the cargo load shipped and increase tourism boats. This developed system aims to replace the traditional navigation aids ((buoys) that have very high cost and exposes to damage) with economic electronic navigational maps supported by the navigational path, as well as, providing real-time data for navigational depths via GPS devices attached to the navigational unit, allowing the navigational unit's skipper to identify the navigational path and safe navigable areas. In addition to providing early warning of non-navigational areas, the developed electronic navigational maps are less expensive, as there is no need for dedicated devices to display these maps or expensive infrastructure.

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Intensity-Duration-Frequency Curves for Hydrologic Design in Egypt Based on Combined Ground Station and Remote-sensing Data

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Keywords: frequency analysis, GPM, hyetograph, intensity-duration-frequency, rainfall

CWW2023 Theme: 4

ABSTRACT

Stormwater management systems are used to limit damage to infrastructure and loss of life due to flooding in urban areas. Design of these systems is typically based on the peak flow estimated using the rainfall intensity for a storm duration corresponding to the time of concentration of the catchment and a return period selected based on risk analysis. Intensity-Duration-Frequency (IDF) curves/equations are developed to give the relationship between the rainfall intensity, duration of rainfall, and return period for storms used in hydrologic design. The Egyptian Code for Design of Potable Water and Sewage Networks (2010) gives limited Intensity-Duration equations for Egypt with no clear distinction between coastal and more arid inland regions [1]. To properly develop IDF curves, rainfall data with high temporal resolution are needed from ground stations. However, in Egypt and in many other countries, access to rainfall data is limited to daily data; hourly or sub-hourly data from ground stations are not generally available. In contrast, remote sensing datasets can be available at sub-daily intervals but typically lack the accuracy required for hydrologic design compared to ground station data. The objective of this study was to combine accurate rainfall data from ground stations with higher temporal resolution remote-sensing rainfall data to develop IDF equations for Egypt. Compared to the equations given by the Egyptian code, the proposed equations include return period and are location specific.

Time series of annual maxima daily rainfall data were obtained for 16 stations from the Egyptian code of practice for urban rural road works in addition to daily data from the National Research Centre (NRC) and from the Global Historical Climatology Daily Dataset (GHCN-d). Rainfall remote-sensing data for Egypt were obtained from the GPM_3IMERGHH v06 dataset which has a temporal resolution of 0.5 hr, a spatial resolution of 0.1°, and a record length of about 21 years from June 2000 to September 2021. The GPM_3IMERGHH v06 dataset is provided by the Global Precipitation Measurement (GPM) and relies on the Integrated Multi-Satellite Retrievals for GPM (IMERG) algorithm which combines satellite microwave precipitation estimates, microwave-calibrated infrared satellite estimates, and precipitation gauge analyses [2].

Frequency analysis was conducted on the daily rainfall data from ground stations using the HYFRAN PLUS software. Several statistical distributions were examined including Pearson Type III, Gamma, Weibull, and 3-parameter log-normal. The Akaike and Bayesian Information Criteria were used to select the distribution that provides the best fit for each station. For ground stations with years of no rain (e.g., Luxor and Aswan), the frequency analysis was conducted for only the years with rain. The actual return periods were determined by accounting for the annual probability of rain.

For the GPM data, running totals were calculated and time series of annual maxima rainfall depths were determined for each duration from 0.5 hr to 24 hr. Frequency analysis was conducted for the time series for each storm duration. The ratios between rainfall depths for various durations and the depth for 24 hr were calculated for the return periods 2, 3, 5, 10, and 20 yr. For each return period, the ratios were multiplied by the corresponding ground station daily depth and a factor of 1.13 to account for the difference between observational-day and 24-hr depths [3]. Least-squares regression analysis was used to fit the resulting depths to the Sherman formula [4] to develop IDF equations for each ground station.

Assessment of the proposed methodology was conducted through application to a rainfall ground station in the Riyadh area, in the Kingdom of Saudi Arabia. IDF curves estimated from GPM data were compared to IDF equations estimated based on 0.5-hr observations for this station [5]. It was found that the GPM-estimated IDF curves for the station in the Riyadh area were in good agreement with the IDF curves estimated using the short interval rainfall data from the station. Agreement was better than for IDF equations generated empirically using the Indian Meteorological Institute (IMD) formula [6]. which converts daily to sub-daily rainfall data.

Annual maxima daily rainfall depths from the ground stations in Egypt and 24-hr GPM depths were highly correlated at a number of stations; e.g., the correlation coefficient for Ras Binas amounted to 0.88. This high correlation indicates that combining the depth ratios estimated from the GPM dataset to the daily depths from ground stations may provide reasonable IDF information. Examples of the IDF curves estimated with the proposed approach are shown in Figure . Rainfall intensities for the different return periods and durations were interpolated over most of Egypt. Examples of isohyetal maps are shown in Figure .

In conclusion, the IDF curves and isohyetal maps that were generated in this study can be used in applying the rational method to estimate peak flow for design of urban stormwater management systems. The GPM-generated IDF curves are needed given the lack of short-interval ground-station rainfall data for direct estimation of IDF curves. However, for accurate assessment of the reliability of the GPM-generated IDF curves, it is recommended to collect rainfall data with high temporal resolution at one or more ground stations in Egypt. This is particularly important in estimating IDF information for storm durations less than 0.5 hr which is the temporal resolution of the GPM data.

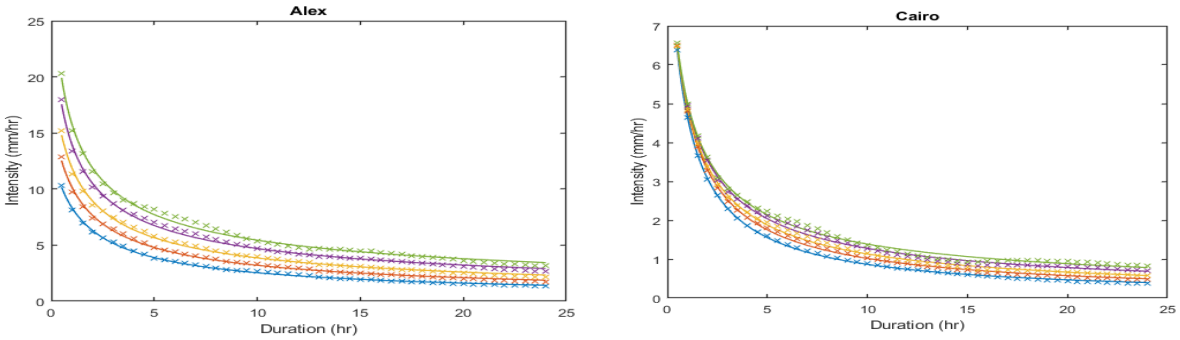

Figure 1. IDF curves generated for a) Alexandria and b) Cairo.

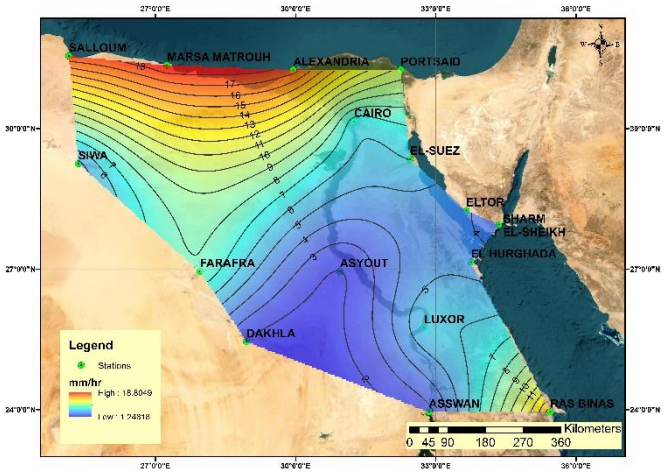

Figure 2. Contour map of rainfall intensity (mm/hr) for storm duration of 0.5 hr and a return period of 10 yr.

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Mitigating Flash Floods and Urban Floods: A Pragmatic Approach to Implementing a Flood Early Warning System in Nigeria

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Keywords: Communication, Early Warning Systems, Flood, Health and Safety, Weather.
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ABSTRACT

Severe weather events and prolonged droughts pose significant risks to human health, safety, and livelihoods. Early warning systems are critical in reducing the impacts of these natural disasters, yet there is a need to improve the accuracy and effectiveness of such systems. This research proposes several strategies for enhancing early warning systems, including investing in better technology, expanding monitoring networks, increasing public awareness, enhancing communication channels, collaborating with local communities, using data-driven approaches, and implementing early warning systems for specific hazards. The study involved a comprehensive review of existing literature, analysis of historical weather data, and consultation with experts in meteorology, emergency management, and community engagement. The research aims to develop recommendations for policymakers, practitioners, and communities to improve early warning systems and enhance preparedness and resilience to severe weather events and prolonged droughts. Ultimately, the research seeks to contribute to the development of more effective and sustainable strategies for addressing climate-related risks and hazards.

Aim

The aim of this research is to enhance early warning systems for severe weather events and prolonged droughts, with a focus on improving accuracy, effectiveness, and overall preparedness to mitigate the impacts of these natural disasters. In Nigeria, there are existing attempts to address flooding; however, upon closer examination of established practices in flood risk reduction, certain deficiencies and limitations have been identified. These areas require thorough scrutiny and should progress beyond the initial stages of planning and inception to the actual implementation phase. These deficiencies form the basis of this research.

Methodology

The approach to the study was divided into three parts; the first was to conduct a comprehensive review of existing literature on floods and flooding events, severe weather events, to identify current challenges and best practices. The second aspect was to analyse historical flooding events in the study area data and patterns to gain insights into the frequency, intensity, and duration of severe flooding events, as well as and the associated impacts on human health, safety, and livelihoods**.** The third aspect put forwards the proposed early warning systems framework developed based on the review and analysis of historical data.

Table 1: Summary of flood impact in Nigeria and Africa for the years 2011–2020.

Year	Numbers of People Affected		Value of Damages (˜000 US$)		Numbers of Deaths	
	Nigeria (% contribution in Africa)	Africa (‘000)	Nigeria (% contribution in Africa)	Africa (‘000)	Nigeria (% contribution in Africa)	Africa
2011	30,915 (2.19)	1,414.6	4,500 (0.45)	1,006.5	174 (25.89)	672
2012	7,000,867 (75.26)	9,302.7	500,000 (49.45)	1,011.1	363 (42.81)	848
2013	81,506 (3.48)	2,345.3	--	147.02	19 (2.59)	735
2014	10,000 (1.05)	948.5	--	126.00	15 (3.02)	496
2015	100,420 (3.99)	2,519.5	25,000 (5.46)	458.00	53 (6.40)	828
2016	12,000 (0.88)	1,369.5	--	295.70	18 (1.91)	943
2017	10,500 (0.66)	1,595.1	--	12.000	20 (5.67)	353
2018	1,938,204 (56.09)	3,455.3	275,000 (35.80)	768.10	300 (40.43)	742
2019	123,640 (2.74)	4,516.3	--	57.100	36 (3.94)	914
2020	193,725 (2.95)	6,575.1	100,000 (22.52)	444.00	189 (14.09)	1,341
Total	9,501,777 (27.91)	34,041.9	904,500 (20.91)	4,325.5	1,187 (15.08)	7,872

Source: Centre for Research on the Epidemiology of Disasters, 2021.
**** Data on value of damages were not available for Nigeria in some years.*

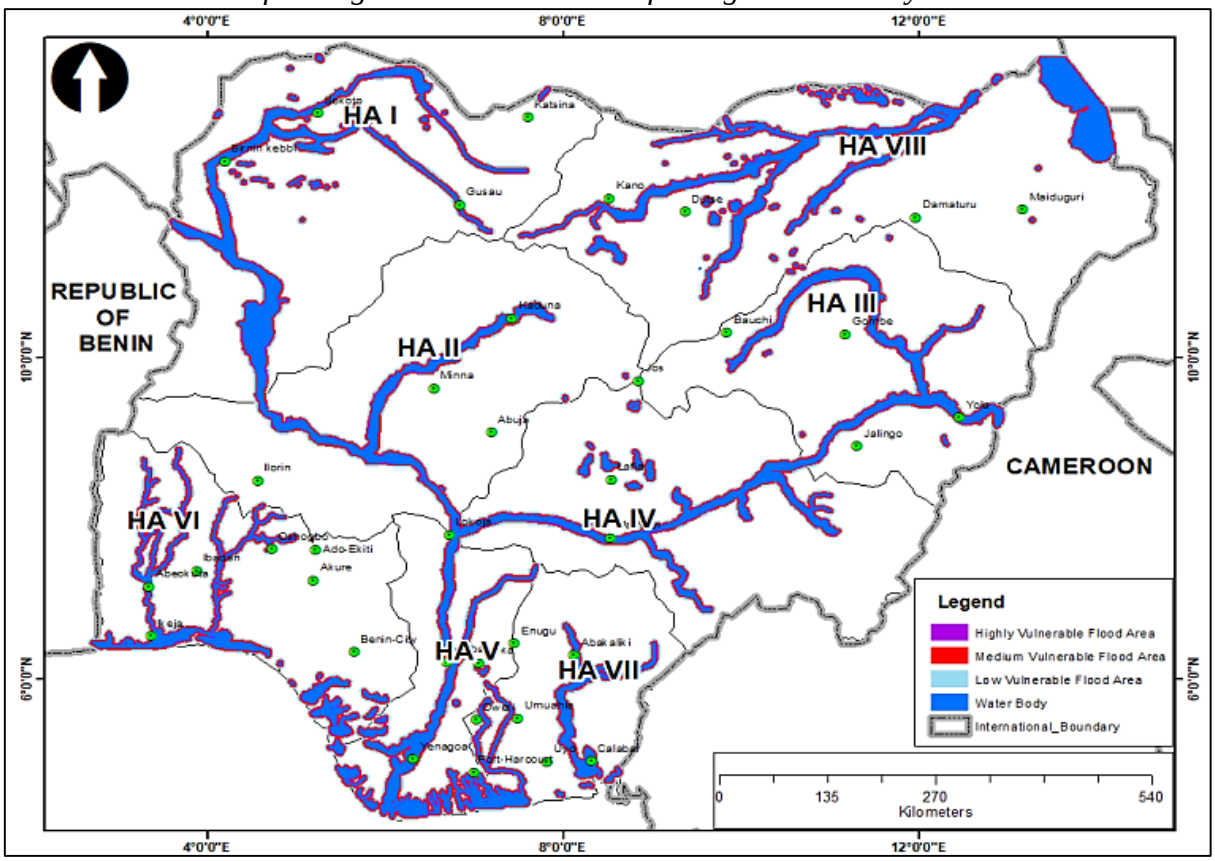

Figure 1: 2020 Flood Zone Vulnerability Map. Source: NIHSA 2020 Annual Flood Outlook (AFO).

Table 2: Comparative Effects of 2018 and 2019 floods in Nigeria

S/No	Effect	2018	2019
1.	Affected Population	1,921,026	130,934
2.	Number of Deaths	204	126
3.	Number of Internally Displaced Persons	210,206	48,114
4.	Houses Destroyed	82,376	29,356
5	Hectares of Agricultural Land Destroyed	156,672	-
6.	Number of Roads Damaged	321	-

Source: NIHSA Field Assessment and NEMA 2019 Flood-summary

The occurrence of flooding over the years, as evidenced by historical data between 2011 and 2020 in Nigeria (Table 1), indicates that flooding is a prevalent occurrence in numerous states across the country, as shown in the accompanying map (Figure 1), with Nigeria ranking top in Africa with highest economic impact and affected population (Table1). Following this is a comparative analysis of the effects of flooding between 2018 and 2019 based on available data.

Conclusion

The study concluded that, Nigeria's urgent need to address flooding is evident, necessitating a comprehensive approach that encompasses local and international interventions. This entails the implementation of various measures, including early warning systems, rapid response mechanisms, flood data collection and modelling, effective urban and spatial planning, flood emergency preparedness, and a strong political will.

Recommendations

Recommendations made included; an increase public awareness and understanding of severe weather events and prolonged droughts through targeted educational campaigns and community outreach programs, enhancing communication channels between different concerned agencies and organisations, and local communities to ensure timely and accurate dissemination of information, and the need to develop data-driven approaches for predicting and assessing the impacts of severe weather events and droughts to facilitate proactive decision-making and resource allocation.

Acknowledgment

This research is independent research, it is strictly the work of the authors

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A Road Map for Alexandria Against Drown Possibility as A Result of Climate Change and Sea Level Rise

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Keywords: Alexandria, Sea level rise, Climate change, Drown, Road map, Integrated early warning system.
CWW2023 Theme: 4

ABSTRACT

Climate change and sea level rise (SLR) will affect many coastal countries over all the world. Alexandria is one of the mega cities located on the Egyptian Mediterranean Sea coast. There is a claim that *Alexandria* is at risk that it may sink beneath the sea due to *climate change* driving sea levels to *rise* after air temperature increase 4 degrees [1]. To study the effects of climate change and SLR on Alexandria, the vulnerable sites of Alexandria coastal area should be identified. Vulnerability assessment will indicate the parts of the coast with low land, which represent weak locations that could be affected by SLR. Adaptation against the phenomena of SLR is very important. The priority will be for the most vulnerable sites and how the risk can decrease. The objectives of this study are to study the possible effects of future SLR with geomorphology and elevation of Alexandria City to identify the vulnerable sites. Also, it is to examine the probability of Alexandria to sink under the waves and to set road map for adaptation to prohibit this claim.

Firstly, we have to divide the phenomena of drowning to temporary drown and permanent drown. Temporary drown, which is a result of receiving significant amount of water for short period of time, may be hours or days, but this excess water finally will pass through the sewer system or be collected outside the city. On the other hand, permanent drown of coastal city can occur when the city and its buildings are fully covered by the water forever. This situation can occur if the sea level become higher than the coastal city roads and land levels. In such case, there will be no way to remove the water and all the parts of the city will be under water. This situation needs hundreds of years to recover, but it will not happen under good adaptation measures.

The investigation of Alexandria Cornish elevation revealed that it is safe in the normal sea condition. Most of the Alexandria coastal area is being protected against 0.5 to 1.0 m SLR [2]. It is characterized by a series of distinct geomorphologic features, including beaches, carbonate ridges, inland depressions (low-lying areas) and harbors [2]. Storm critical conditions was set as 3 m above mean sea level at Cornish level. The most vulnerable sites of Alexandria along the Cornish due to the storm critical level are the Manshia at Eastern Harbor and Beer Masoud and Mandara. This is confirmed by the findings of Frihy and El-Sayed [2]. In case of sea water rise to 0.2 m, the new critical storm level will increase to

3.2m above the mean sea level, which may add 3 sites more at Sidi Bisher to the other Alexandria Cornish at risk.

In the absence of any adaptation, Alexandria is projected to be affected by SLR in terms of the number of people at risk of flooding annually in a 4℃ -warming scenario [3]. Figure 1 shows SLR under the two RCP (Representative Concentration Pathways) scenarios 4.5 and RCP 8.5. The RCP 4.5 is with 538 ppm CO_2 and increase 3.11°C/100y, but the updated best estimates under Shared Socio-economic Pathways, SSP2-4.5 is 2.7°C in 2100. Scenario RCP 8.5 with 936 ppm CO_2 with increase 7.14°C/100y, is the updated best estimates under SSP5-8.5 is 4.4°C in 2100 [4]. The increase of sea level till 2100 with both scenarios RCP 4.5 and 8.5 have polynomial trends with models expressed by: $y= 2E\text{-}08x^2 - 0.0005x + 12.988$ and $y= 6E\text{-}08x^2 - 0.0033x + 47.759$, respectively.

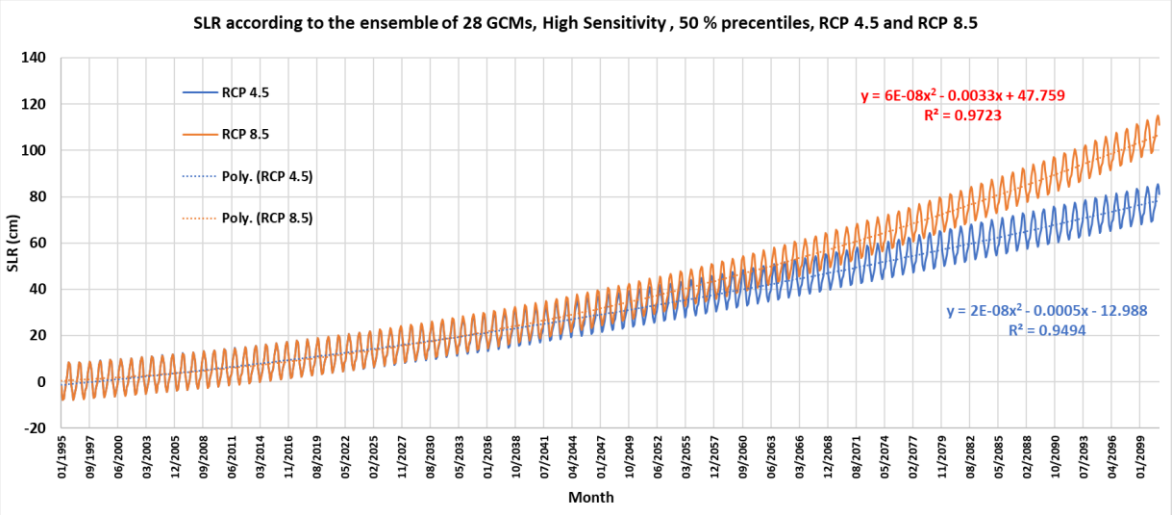

Figure 1. SLR in Alexandria coastal water under scenarios RCP 4.5 and RCP 8.5.

Adaptation can be executed by innovative wave protection structures to prevent the consequences of SLR, at the high-risk vulnerable areas against inundation and encouraging the application of soft structure such as sand nourishment. This may include change the shape of the coastal wall of the Cornish to be of two layers, the lower layer is to be closed solid till 0.3 m and the upper layer about 1 m could have openings. Adaptation also has to start with raising the height of the infrastructure (where possible) or raising the height of the beach (beach nourishment). In the case of the low land sites, their levels can be increased, for example, elevation of Cornish streets can be increased by10 cm every 10 years with keeping the slop toward the sea. Adaptation includes also retreat for the new buildings or coastal activities by progressively restricting land use further and further inland with time. Increase the vegetation cover of the city to decrease the CO_2 in the air and these mitigation measures would be effective if it applied on a global scale. Control of the sea water pollution gives chance for the algae and marine plants to grow healthy and increase its diversity to consume more CO_2 and reduce the acidification phenomena. Other measures include decrease of using fossil fuels in the means of transportation (such as the buses for residence) and replace them by electrical power vehicles, checking the width and height of the open channels (drains and canals) at their outlet to the sea, such as West Elnobareya Drain, Elnobareya Canal, using artificial dykes along the border of the coast and coastal lake to prevent the expected increase of its water to reach Alexandria, increase awareness for public about the Climate Change, clear codes and instruction for the contractors to raise the new

buildings to higher levels than the old building and prioritize protection of the regions of very high commercial or community value.

Climate change have several adverse impacts on the coastal zones of Alexandria, Egypt e.g., SLR, causing extreme events such as storm surges, flooding, and permanent inundation. Establishing an efficient integrated early warning system has become a must in order to deal with the climate change-related risks in a more proactive way (Figure 2). This integrated early warning system is based on real-time measurements and an automated analysis with prediction system to provide data-driven perceptions for decision-makers to establish more efficient and proactive disaster management strategy. The proposed early warning system idea is applicable for all the coastal cities against climate change disasters with monitoring and prediction of the coastal phenomena and its extreme events.

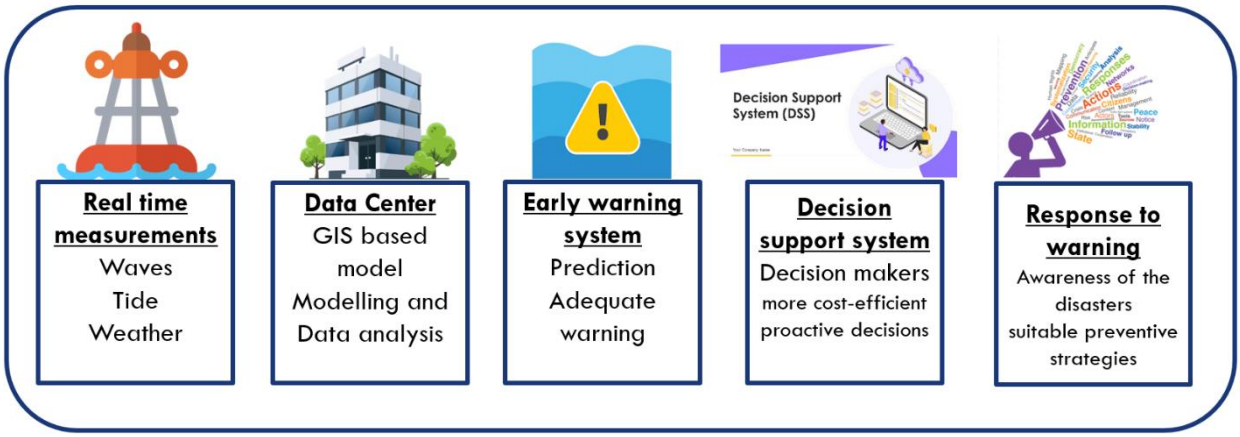

Figure 2. Proposed integrated early warning system.

We conclude that, adaptation strategy to prevent the vulnerable areas has different actions. Whenever, sea level become higher, actions include making the coastal streets consistently higher, increasing of the coastal protection measures with soft structure, integrating the adaptation plans and strategies to climate change and SLR in the national development plans. Finally, an integrated early warning system will be important to decision makers. The system will help stakeholders to sustain high economic values of their businesses and empower the decision makers to execute more cost-efficient proactive decisions.

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Dominant Flow Driving Mechanics at Different Temporal Scales along the Gulf of Aqaba

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Keywords: Gulf of Aqaba, Flow Circulation, Vertical Velocity, Density Currents, AEM3D.
CWW2023 Theme: 4

ABSTRACT

Gulf of Aqaba (GA) becomes one of the world most attractive spots now adays with the massive potential development of Neom City. Thus, it is important to understand the dynamics governing such water volume motion that should have a direct influence on the sustainability of some of the proposed coastal mega-projects such as; The Line, The Cube, Sindalah Island, etc. during severe storm events. The gulf is a unique water body that exists in the Eastern flank at the northern end of the Red Sea (RS) basin. Such uniqueness can be observed in three main features; the semi-confined water body; the elongated shape; and spatially variable bathymetric formation and shoreline irregularity. The domain can be divided into three sub-basins based on the width and depth irregularity; the northern; central; and southern basins. Basically, such wide variation between sub-basins configurations governs the regional horizontal flow circulations of the GA presented with consecutive pairs of flow cells. However, the vertical flow circulation is mostly governed by coastal (i.e., winds) and oceanographic (i.e., density currents and tidal currents) driving mechanisms. The GA basin is too large to be considered as a sea and too deep as well to be considered as an ocean. We believe a fatal mistake is to assume flow velocity consistency along depth as well as studying the GA circulations from a single perspective.

The region is described with high temperatures during the summer. As a result, the upper layer is heated than the lower layer leading to a remarkable stratification of the water volume during that season [1-3]. Moreover, due to combined effect of high evaporation rates [4] and minimal fresh water runoff, GA becomes high-dense seawater in comparison to RS water density [5]. Accordingly, high exchange of water volumes induced by density currents between the GA and RS basins [6]. Once the RS thermos driven inflow penetrates the GA system flowing towards the north tip, the surface flow cools and thus sinks in the lower layer flow at the edges. Attributed current to the thermocline flow is reported in a range of 2-4 cm/s [7].

The wind-driven current plays an important role in GA upper circulation patterns. Most of the time winds are always blowing, by a speed that reaches 12 m/s, along the Gulf stream

pointing from north to south [8]. During the day, the wind is calm at night and increases in speed at morning, reaching its peak in the afternoon as the temperature is maximum. Tidal currents induced in RS are amplifying with additional in and out flows to the GA circulation towards north that is again controlled by the Straits of Tiran (ST) bathymetric configurations [9]. The diurnal tidal constituents are the luni-solar diurnal component (K1) but in regard to the main semi-diurnal constituent is the lunar component (M2) [10]. Tidal flux over the month period occupies the upper surface layer with a depth of 150 m in summer [11].

The three-dimensional (3D) Reynolds-averaged Navier-Stokes' equation, coupled Hydrodynamic-Aquatic Ecosystem Model (AEM3D) developed at the University of Western Australia, was applied in this study. AEM3D is a hydrostatic finite-difference hydrodynamic model that predicts the velocity and temperature distribution on a vertical level grid subject to external environmental forcing. The model employs a three-stage numerical algorithm for scalar transport (e.g., temperature, salinity, or tracer): (1) vertical mixing by the mixed layer model; (2) advection of the scalar field by the resolved flow; (3) horizontal turbulent diffusion using a constant eddy viscosity turbulence parametrization. The fundamental numerical scheme was adapted from the Tidal, Residual, Intertidal Mudflat (TRIM) model [12].

The seabed formation of the GA is unique; therefore, information of bathymetry features was collected from various sources seeking the best resolution as well as accurate description of the gulf basin bottom. These sources are the European Marine Observation and Data Network (EMODnet), Navionics Sonar Maps, Satellite Driven Bathymetry (SDB) and Shuttle Radar Topography Mission (SRTM). Hence, the ground elevations were compiled in order to generate an informative map for the GA. To account for exchange between RS and GA, the grid was forced with an open boundary at Strait of Tiran, where hourly water level data, extracted from ERA5, and previous field observations, presented in Karati et al. [13], of temperature and salinity profiles along 200 m isobath were specified. Surface meteorological forcing was collected from ERA5, in which hourly wind speed, wind direction, relative humidity, air temperature, atmospheric pressure and solar radiation were applied uniformly over the model grid. In addition, initial condition water temperature and salinity profiles data were identified at three locations for each along GA.

A uniform low-resolution grid of 600 m × 600 m was created to model the hydrodynamics of GA. Although, in the vertical, 75 levels were specified with non-uniform resolution, starting with 1 m at the surface and increasing gradually beneath the depth of the summer thermocline to 40 m spacing at the maximum depth of 1000 m, at which the bed level at deeper zones was set to 1000m. For all simulations, the model ran for 14 days, starting 18 August 2016 and ending 31 August 2016, based on the availability of boundary condition forcing data. The time step was 60 seconds to satisfy the Courant-Friedrichs-Lewy stability condition.

In order to examine the impact of the density currents on the flow circulation of the water column, two hydrodynamic forcing conditions; Scenario 1 of tide fluctuations only and Scenario 2 of tide fluctuation associated with density profiles were tested. In Figure 1, average flow velocities are calculated over the first 200m water depth which is roughly the width of the upper stratified layer at four selected locations along the GA basin longitudinal axis. The plot indicates a significant increase in cumulative velocities around 12 cm/s instead of a negligible velocity induced by a stand-alone tide. Therefore, this is clear evidence on

the significance of considering the density currents vertical profiles in the GA flow circulation bearing in mind that both currents are propagating towards north.

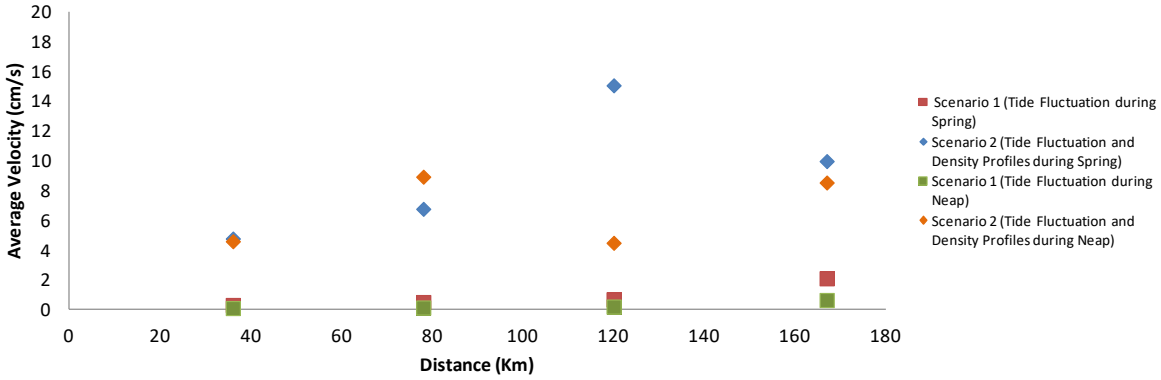

Figure 1. Extracted model average flow velocity over 200m depth at different locations along the basin of tidal only and tidal/density currents at selected random time. Note station 0.0 is at the basin northern tip location.

Furthermore, at a random selected time, as a sample, a velocity participation percentage of each current component is indicated as shown in Figure 2. The plot implies a noticeable contribution of density currents when compared to wind induced currents. The density current can reach out to 80% contribution at one location but not less than 40% anywhere else. Bearing in mind that the two currents are generally opposing in direction while wind currents are only limited to the first few meters of the water column but density currents can extend at least 150 m in depth, the resultant surface wind flow speed can be reduced considerably due to density currents travelling in the against direction attenuating the total current velocity.

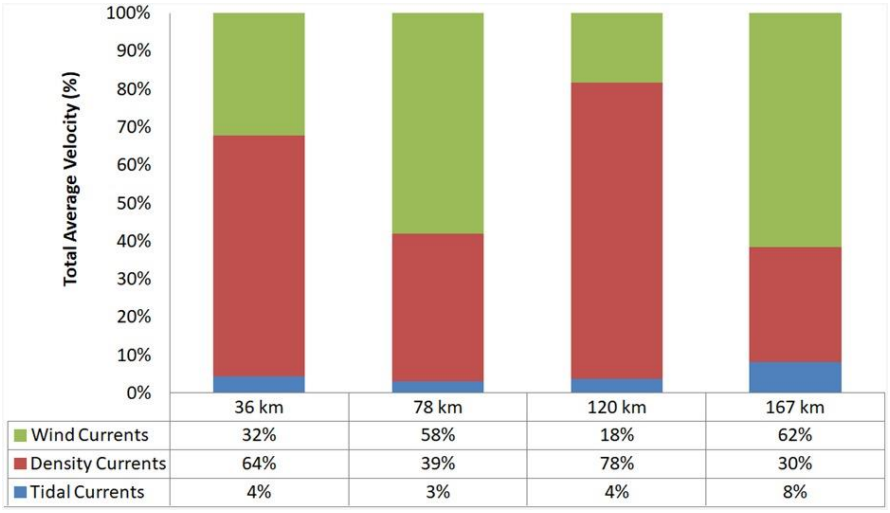

Figure 2. Extracted model total average velocity participation percentage over 200m depth at different locations along the basin of three current components at selected random time. Note station 0.0 is at the basin northern tip location.

In conclusion, the performed simulations indicate a remarkable impact of thermodynamics that have to be considered in the flow circulation modelling. This could have a direct influence and implications such as; dissipative turbulence and eddies, internal waves, stagnant/standing flows, and many other environmental negative impacts. Considering these impacts could improve an early warning system for the new coastline. It can be achieved by

implementing an appropriate simulation for water dynamics to identify stagnant locations which may result in environmental risks. For instance, the coast guard can develop contingency plans in order to manage oil spill hazard that may occur within the defined stagnation points.

On the other hand, further hydrodynamics investigation required for the offshore developments within GA shall include, in first place, the flow induced by density currents since it contributes with an average of 53% of total participated currents along GA, as illustrated in Figure 2.

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Assessment of Potential Improvement of Crop Productivity and Water Use Efficiency to Sustain Future Crop Production of Major Crops in Egypt

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Keywords: Food security, Remote sensing, Scenario development, Sustainable intensification, Water productivity.
CWW2023 Theme: 5

ABSTRACT

Egypt is facing the challenge of sustaining food production for its ever-growing population, a situation that is likely to be exacerbated by climate change [1] as well as by future water-related developments upstream the Nile [2] [3]. Most recent research suggests that Egypt's water deficit (the gap between renewable water resources and actual water use, currently about 21 billion cubic meters (BCM) [4]) as well as virtual water embedded in food imports will increase to sustain future food supply [5] [6] [7]. Not only will Egypt face a significant challenge with securing enough water for food production, but it will also encounter the challenge of expanding cultivated areas. Although the cropping intensity (the fraction of croplands that is harvested) in Egypt is quite high (145%), the country still needs to expand the current harvested area of 5.6 million hectares (M ha) to reach about 9.2 M ha, to sustain the domestic crop production by 2050, following the current production efficiencies [5].

Thus, this research investigates the potential of increasing productivity of major crops in Egypt, namely rice, maize, wheat, and clover (berseem), and consequently estimate future water and land resources needed to sustain supply of these crops through 2050. The study developed an approach using open-access gridded datasets from FAO's portal to monitor water productivity through open access remotely sensed derived data (WaPOR v2.1) and GIS techniques to estimate three productivity indicators in the Zankalon region in the Nile Delta (Figure 1) for the selected crops: (1) yield (Y = production/harvested area), (2) crop water productivity (CWP = yield/actual evapotranspiration), and (3) transpiration ratio (Tr = transpiration/actual evapotranspiration). Next, productivity indicators were analyzed, and potential improvements were estimated through percentile analysis (80% and 90%), and used to develop scenarios for future demand for water and land to sustain production of selected crops through 2050.

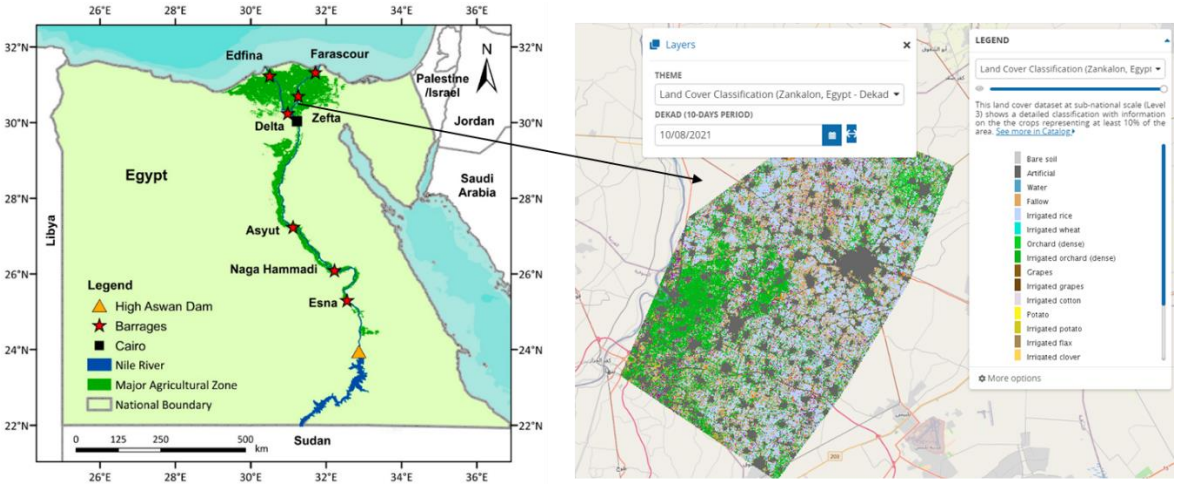

Figure. 1. Location map of the Zankalon region in Egypt, after [8]

Results revealed that Tr had the least potential for improvements (1%–3%) as Tr values were already high (Tr for all crops = 0.79–0.84). Yield values could be improved by 14–21%, 11–17%, 8–12%, 7–12%, for rice, maize, wheat, and berseem, respectively. Similarly, CWP of rice, maize, wheat, and berseem values could be improved by 6–10%, 6–9%, 4–6%, 4–7%, respectively. To sustain the domestic supply quantities by 2050, Egypt needs to increase the production quantities of rice, maize, wheat, and berseem by 128%, 78%, 69%, and 71%, respectively, of the 2016-2020's average production quantities. A cultivated land area of about 6.4 million hectares is needed to sustain domestic production of rice, maize, wheat, and berseem by 2050, following the average yield values scenario. Similarly, about 40 BCM of water is needed to sustain production of these crops by 2050.

Based on the key findings of the current research, Egypt is expected to face challenges in satisfying its future demand for the four crops by 2050 given the substantial water and land required resources to produce sufficient quantities. In the light of these findings, the study proposes a few development strategies that could potentially enable the country to sustain crop supply for its future population. The strategies comprise (i) managing population growth, (ii) minimizing food waste and losses, (iii) gradually changing dietary habits, (iv) improving the efficiency of water systems, (v) increasing water resources, (vi) revisiting food imports and exports, (vii) optimizing water allocation, and (vii) research and data monitoring. Challenges and opportunities towards realizing these strategies do exist. For example, while reducing the rapid population growth appears to be a straightforward approach to ease future water scarcity, it may conflict with deep-rooted Egyptian traditional values [9]. Similarly, changing dietary habits by Shifting from a meat-based to a plant-based diet offers another opportunity to conserve water. However, it may conflict with aspects of the food security concept that emphasize that available food should also be socially and culturally preferred and accepted [10], which may not be so when changing dietary habits. Nevertheless, a gradual shift in dietary habits and managing the population growth appear to be reasonable strategies to cope with the expected future insufficiencies of water resources [5]. The methodological approach and datasets used in this study can be used as an operational tool for evidence-based policy development in agricultural water management in Egypt and beyond.

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Assessment and Adaptation Measures to The Impacts of Climate Change on The Evaporation Losses from Lake Nasser

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Keywords: climate change, water resources, evaporation loses, Lake Naser, Floating Photovoltaics (FPV)
CWW2023 Theme: 5

Introduction

Climate change is expected to have significant impacts on different sectors specifically water, energy, and food. According to the IPCC reports, the mean temperature will rise at the end of the century between (1.4-4.8)^{o} C. Egypt is extremely sensitive to the effects of climate change, which could have disastrous effects on the nation's economy and food security. Water scarcity is a significant challenge to the social and economic development which requires adequate management strategies. Reducing evaporation, which causes a significant quantity of water losses from lakes is one method of conserving the available water resources. Rising global temperatures cause changes in atmospheric circulation and increase evaporation rates. Overall, 20% of water inflow to lakes is lost to evaporation, and approximately 10% of lakes in arid places are experiencing significant evaporation losses of more than 40% of their entire inflow. Global lake evaporation will increase 16% by the end of the century due to climate change. Evaporation losses from Lake Nasser is a national problem. The annual evaporation losses range between 10 and 16 BCM [1], which equals to 20-30% of the Egyptian share from Nile River. The objective of this study is to determine how climate change affect evaporation losses from Lake Nasser and provide suitable mitigation strategies.

Materials and Methods

Lake Nasser located between 23° 58′ and 20° 27′ N and 30° 07′ E and 33°15′ E at the upstream of High Aswan Dam (HAD). The length of the lake is 500 km, 350 km in Egypt and 150 km in Sudan. The lake's surface area is about 6500 km^2 at level 182 above Mean Sea Level, with average width of 13 km, and total storage capacity 162 billion m^3 (BCM) [1]. Climate data from NASA dataset for the period (1981 to 2021) are used to estimate the water losses from the lake. The monthly evaporation from Lake Nasser is calculated using the average monthly data for temperature, relative humidity, and wind speed for 41 years.

The bulk aerodynamic method is used to calculate the evaporation losses from the lake. It is widely used for estimating evaporation losses from large lakes and reservoirs. Equations 1 is used for calculating the evaporation from lake Nasser [2].

$$E = NU_2(e_s - e_a) = NU_2(0.611\ exp(\frac{17.27T}{T+237.3}) - \frac{RH}{100}e_s) \quad (1)$$

Where, E represents the evaporation losses (mm/day), N represents the lake coefficient [1], U_2 represents the wind speed (m/sec), e_a represents the actual vapour pressure of air (kpa), e_s is the saturated vapour pressure (kpa) at water surface temperature, RH is the relative humidity, T is the temperature (C)

The annual volume of the water lost by evaporation was calculated using Equation 2 based on the annual evaporation rate [2]:

$$V = EA\ (365/10^6) \quad (2)$$

Where, V represents the annual volume of water loss (BCM), A is the surface area of the lake (km^2).

Several methods can be used to reduce the water losses from open water surfaces which have been discussed and compared by Abd-Elhamid et al. (2021) [2]. Floating photovoltaic (FPV) is used in the current study for covering parts of the Lake. Water savings due to FPV system was estimated based on evaporation rate and the area covered. Lake Nasser that located at Aswan, where the annual average solar radiation is ranged from 2439 to 2472 KWh/m^2, which indicates the suitability of this area for efficient energy production almost all the year (Solar Atlas of Egypt) [3]. The potential energy production from lake Nasser is calculated using the following equation:

$$\textit{Potential energy production}\ \ E = A \times r \times H \times PR \quad (3)$$

Where, E represents the Energy (KWh), A represents the total solar panel Area (m^2), r represents the solar panel yield or efficiency (%), H represents the annual average solar radiation, PR represents the performance ratio, coefficient for losses (range between 0.5 and 0.9). Different scenarios of climate change impacts on water losses and different covering ratios (10%, 20%, 30%, 40% and 50%) of lake's surface area using FPV have been studied as summarized in Table 1.

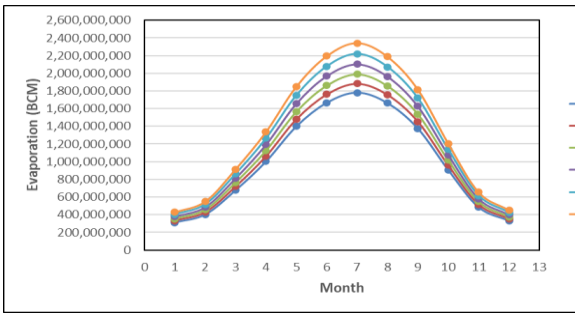
Table 1. Scenarios applied in this study

No	Scenario	1	2	3	4	5	Notes
		20%	40%	60%	80%	100%	
1	Temperature (T° C)	1	2	3	4	5	T_{max} = 5° C
2	Wend speed (U%)	1	2	3	4	5	U_{max} = 5 %
3	Relative humidity (RH%)	-1	-2	-3	-4	-5	RH_{max} = -5%
4	Annual solar radiation (H%)	2	4	6	8	10	H_{max} = 10%
5	Covering with FPV (A%)	10	20	30	40	50	Total area of the lake (5775 km^2)

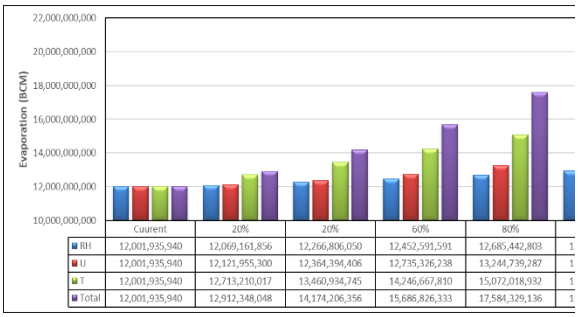
Results

Equation 1 is used to calculate the average monthly evaporation for the period (1981-2021) as shown in Figure 1a. The maximum evaporation rate occurs in the summer in July (1.78 BCM) and the minimum (0.31 BCM) during the winter in January. The total annual water

loss from the lake is 12.0 BCM (21.6% of the inflow), which match with other studies (e.g. Abd-Elhamid et al. [2] estimated the loss by 12.0 BCM, Abdel Wahab et al. (2018) [4] estimated the losses in range from 12.3 to 12.9 BCM, and Hamdan and Zaki [5] estimated the losses by 13.62 BCM). Then different scenarios (Table 1) are applied to assess the impact of climate change on water losses from the lake. The impact of increasing temperature, wind speed and decreasing the relative humidity on monthly and annual losses are shown in Figures 1a and b. For the five studied scenarios, the temperature increase has increased the losses to 0.7, 1.5, 2.25, 3.1 and 4.0 BCM/year, the wind speed increase has less impact and increased the losses to 0.12, 0.36, 0.74, 1.25, 1.9 BCM/year. However, the temperature increase has decreased the relative humidity which increased the losses by 0.1, 0.27, 0.45, 0.69, 1. 0 BCM/year. The total losses from the lake due to climate change reached 0.9, 2.1, 3.7, 5.6, and 8.0 BCM/year that represent 23.3, 25.5, 28.3, 31.7 and 36% of the inflow compared to the current losses (21.6%). According to the highest scenario, the losses will increase 14.4% (8.0 BCM) from the inflow (55.5BCM) which less than the expected worldwide (16%).



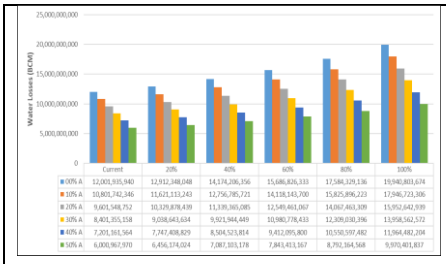
(a) Monthly evaporation



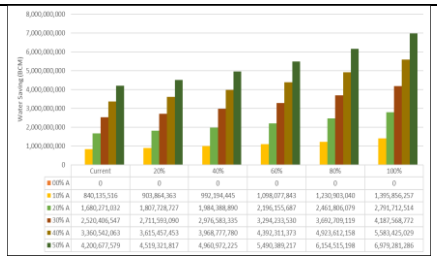
(a) Total evaporation

Figure 1. The monthly and annual evaporation from Lake Nasser for different scenarios

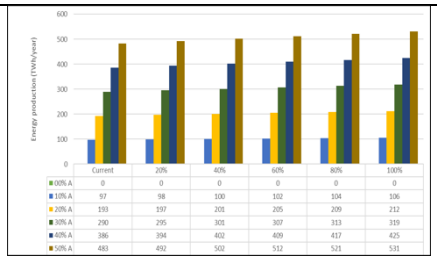
To adapt with climate change impacts on the lake, different scenarios of covering the lake by FPV are studied; 10%, 20%, 30%, 40% and 50%. The surface area of the lake is 5775 km^2, and annual evaporation of 12.0 BCM is adopted to estimate the annual water saving. Covering 10%, 20%, 30%, 40% and 50% of the lake can save about 0.84, 1.7, 2.5, 3.4, and 4.2 BCM/year respectively (70% of the losses). Figure 2a and b show the relation between the area covered and water losses and water saving from the lake. The energy production is calculated using Equation 3 for the five scenarios of covering. The potential energy production is 97, 193, 290, 386, 483 TWh/year that will increase due to increasing the temperature. Figure 2c shows the relation between the area covered and energy production from lake Nasser for five scenarios. The results in Figure 2 present the current situation (12.0 BCM) which will increase in the other scenario to as shown in Figure 3c.



(a) Annual water losses (BCM)



(a) Annual water saving (BCM)



(c) Annual energy production (TWh/y)

Figure 2. Relation between area covered and annual water saving and energy production from lake Nasser

Conclusion

Evaporation losses from lake Nasser range between 10 and 16 BCM/year, which represents 20-30% of the inflow to the lake. In this study, the evaporation from the lake is estimated by 12.0 BCM/year. Five scenarios of climate change have been studied to assess its impact on water losses. The results reveal that, the evaporation losses from the lake will increase by 23.3, 25.5, 28.3, 31.7 and 36% from the inflow compared to the current situation (21.6%). According to the highest scenario, the losses at 2100 will increase to 8.0 BCM (14.4%) from the inflow (55.5 BCM) which within the expected worldwide rate (16%). Covering parts of the lake using FPV could be a suitable solution to decrease the evaporation losses and produce energy. Different scenarios of covering have been studied to cover 10, 20, 30, 40 and 50% of the lake area. The results reveal that increasing the covered area decreased the evaporation losses and increased the energy production. The annual losses from the lake decreased by 0.84, 1.7, 2.5, 3.4, and 4.2 BCM and the electricity production from FPV system reached to 97, 193, 290, 386, 483 TWh/year, for the five scenarios of covering that will increase in the future with increasing the temperature. Results of this study could help policymakers to put adaptation strategies to the likely climate change impacts in order to reduce the losses from the lake Naser and increase the water resources and renewable energy.

Acknowledgment

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Avatar-based communication to achieve the SDG´s International Cairo Water Week Conference on different themes addressing water issues

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Keywords: Avatar-based teaching and learning, SDG´s in VR
CWW2023 Theme: 5

ABSTRACT

RWTH Aachen University aims to best prepare students for the implementation of the United Nations' Sustainable Development Goals (SDGs). Achieving the SDGs requires the knowledge and expertise of a variety of experts from different disciplines. To this end, RWTH Aachen University has decided to develop cross-site and cross-disciplinary scenarios in which students can collaborate on specific tasks using avatars in virtual reality (VR) models. This allows students from different fields of study to analyze real-world problems, such as the development and operation of seawater desalination plants, through concrete assignments and develop solutions together. The advantage is the location independence, as students do not incur travel time and costs, and their individual CO2 footprint is not significantly increased. The implementation in VR thus enables targeted transdisciplinary collaboration.

The necessary VR software was developed at the Department of Engineering Hydrology with funding from the National Research Ministry and is available to all universities as an open-source solution for free use.

Projectdescription

In the course of the advancing development of Virtual Reality (VR), the application of avatar-based teaching and learning has proven to be a promising approach. This article describes a project in which VR was used to enable students from different universities to collaborate without the need for physical travel. The collaboration was facilitated using the open-source software MyScore developed by RWTH Aachen University. The project tasks were designed to address real sustainability issues within the context of the SDG 2030 goals. The article will describe the individual steps of the VR application.

Introduction to VR Collaboration:

The first application involved introducing students to VR collaboration. They were given access to the MyScore platform and familiarized with its basic functions. By using avatars, students were able to navigate virtual environments, interact with each other, and communicate. This immersive experience facilitated the exchange of ideas and eased collaboration among participants.

During this application, technical aspects such as operating VR devices, navigating the virtual environment, and using communication tools within the platform were also

addressed. Students were able to familiarize themselves with the features and gain initial experience to be prepared for the subsequent applications.

Introduction to the Specific Problem and Teamwork for Sustainable Problem Solving

In the next step, the specific task was presented, and the students were explained the concrete requirements they had to address. The tasks were highly diverse. In the collaboration between aspiring engineers from RWTH Aachen University and aspiring lawyers from Bucerius Law School in Hamburg, for example, the task was to expand an existing flood retention basin at the Hamburg Airport site. Four possible areas with different pros and cons were provided.

The interdisciplinary teams had to create a feasibility study based on engineering and legal aspects and present it to a commission at the end.

In a collaboration between RWTH Aachen University and Politecnico di Milano, the specific subject of discussion was a seawater desalination plant. Here, technical and economic issues were addressed in a collaborative manner.

The teams varied in size; in the collaboration between engineers and lawyers, the teams consisted of four people (two from each discipline). In the application with Politecnico di Milano, students were able to organize themselves into groups of different sizes. Students were encouraged to contribute their different perspectives and expertise to develop innovative solutions.

The students had the opportunity to explore virtual environments, gather information, and exchange ideas. The immersive nature of VR allowed participants to identify more closely with the problems and explore alternative solutions. Collaboration in teams promoted communication skills, teamwork, and creative problem-solving.

Presentation and Evaluation of Solutions:

Subsequently, the teams worked on their respective solutions. Different conditions applied to this stage as well. In the collaboration between lawyers and engineers, the entire process was limited to a weekend. The task was given on Saturday morning, allowing time for clarification of any uncertainties. After that, the teams worked until Sunday afternoon and had to submit their result presentations by 3:00 PM. From 4:00 PM onwards, the group work was presented in a VR setting, simulating a session of a senate commission.

Figure 1. Example of a VR scene in MyScore

The students did not receive credit points for this project; their participation was purely driven by intrinsic motivation.

In contrast, the project between RWTH Aachen University and Politecnico di Milano spanned a semester. The task was given at the beginning of the semester as part of an existing

module. The presentations took place in the second half of the semester, and the project work contributed to bonus points for the final module examination.

The results were evaluated by the instructors. Evaluation criteria included the creativity and originality of the solution approaches, their effectiveness in addressing sustainability problems, and the quality of the presentations themselves. The evaluations were used to select the best solutions and also served as feedback for the students to further develop their skills.

Conclusions

The project utilizing avatar-based teaching and learning with VR was successful and achieved positive outcomes. Students were able to collaborate effectively without being physically present in one location. The immersive nature of the VR environment facilitated interaction and the exchange of ideas, leading to creative solution approaches.

The use of the MyScore platform provided by RWTH Aachen University proved reliable and suitable for such tasks. After initial difficulties, students were able to familiarize themselves well with the features and focus their attention on the content and collaboration. The VR technology allowed participants to experience a realistic environment and actively contribute to solving sustainability problems.

The presentations and evaluations of the solutions demonstrated that students developed creative and effective approaches to problem-solving. The application of avatar-based teaching and learning with VR has proven to be a promising approach to facilitate collaboration among students from different universities and contribute to addressing global challenges.

In conclusion, the application of avatar-based teaching and learning with VR has great potential and should be further explored in future educational projects. It is expected that this innovative method can make a positive contribution to the development of communication, teamwork, and creative problem-solving skills to successfully tackle the challenges of the SDG 2030 goals.

The software has been awarded the Comenius EDU Medal. This award primarily promotes didactic multimedia products that are outstanding in terms of pedagogy, content and design. The software, along with an associated server, is available to interested universities at the Department of Engineering Hydrology for use, requiring only the local acquisition and provision of VR headsets.

Acknowledgment

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Cairo, 29 Oct- 2 Nov, 2023

Holistic Water Resource Management: A Cocreation Strategy for Resilient (Coastal) Arid Areas

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Keywords: Coastal areas, climate action, food-water-energy nexus, cocreation methodologies, regenerative tourism, hybrid governance
CWW2023 Theme: 5

ABSTRACT

With a population of over 300 million people situated on coasts, including 20 of the planet's 33 megacities, low-lying coastal areas represent one of the most vulnerable to the impacts of climate change (1). Sea levels are rising, while flash floods and coastal urbanization pose serious environmental damage via the elimination of bio-diverse habitats and the deterioration of ecosystems and erosion (2). These environmental effects also cause socio-economic degradation that leads to specific social dynamics marked by the marginalization and displacement of certain ethnic minorities (3). As such, coastal regions demand immediate and effective interventions to promote environmental and social stability. This study explores the impacts of climate change on the food-water-energy nexus within Egypt's coastal context, where the government plans to expand agricultural land to promote food security. The study also investigates effective, interdisciplinary collaborations and interventions that will increase the capacity of current water management practices and create roadmaps to coherent policies and partnerships across institutional levels. Two case studies—the bottom-up Habiba Community and the top-down Moghra Initiative—are analyzed through Theory of Access and Hybrid Governance lenses. These cases reveal adaptable strategies for sustainable regional development by informing decisions on off-grid, solar-based water systems that benefit small and medium-sized farmers, thereby enhancing food security, and addressing various challenges, including environmental, socio-economic and political issues. Methodologically, multidisciplinary research informs best practices and co-creation methodologies applicable beyond Egypt.

Food-Water-Energy Nexus Challenge

To address climate and population driven food-water-energy nexus challenges, the Egyptian government plans to expand agricultural land by 2.5 million acres (10,000 km^2) while simultaneously developing more adaptive and sustainable agricultural practices for its arid regions. By pairing more arable land within Egypt's borders with better farming practices,

the government aims to improve food security (consistent access and stable prices) for its citizens, reduce the global climate impacts of farming practices (reduced net CO2 emissions), improve local biodiversity and improve management of scarce freshwater resources.Through the lenses of Theory of access (4) and Hybrid governance (5) the paper analyzes two governance case-studies in Egypt -- one top-down and the other bottom-up -- to compare the benefits, drawbacks and possible co-benefits of each organizational strategy towards achieving more adaptive and sustainable agricultural practices in (coastal) arid regions. Because one in three people live in drylands or arid regions (UN-Habitat), these case-studies have broad applicability to billions of food and water vulnerable citizens.

Cases

The **Habiba Community** initiative in Nuweiba, South Sinai Egypt, is a successful regenerative tourism initiative that focuses on responsible tourism practices, regenerative agriculture and community-based development models. Through collaborations with the Desert Research Center and others, they have established a network of 100 family-owned farms in Nuweiba. They have also created a cooperative that ensures access to food, supports local economic growth and provides education and healthcare opportunities. This bottom-up strategy showcases the effectiveness of inclusive methods in attracting individuals and private initiatives to drive innovative changes in areas such as education, resource management, multicultural relations and sustainable energy and water systems. They are currently implementing an off-grid, solar-based water utility system.

The **Moghra Initiative** in Moghra Oasis, Marsa Matrooh, is a successful demonstration of solar and water cleantech utilities. It has implemented a Sustainable-Agro-Village and Entrepreneurship Park (SAVE) over a 230-acre area, operating as an Independent Power and Water Producer (IPWP) for 20 years. The initiative utilizes a Buy Now, Pay Later (BNPL) model. The project effectively reduces CO_2 emissions by 1,700 tons per year, lowers energy and water costs by 75%, and produces 730,000 cubic meters of green desalinated water annually for irrigation purposes. This top-down approach offers integrated, affordable and customized solar solutions for water to small and medium farmers. It provides clean energy and precise water supply as a service, where farmers only pay for what they consume when they sell their produce based on a pre-set tariff. The initiative operates through long power and water purchase contracts, with minimal water, carbon and environmental footprint.

In both seed cases, the research emphasizes the importance of flexible and adaptive governance strategies embedded within policies to minimize environmental impact and support the development of coastal communities and their actions for desert regeneration through agricultural and agroforestry activities. By incorporating bottom-up community initiatives and top-down private initiatives, the paper aims to illustrate that a collective and reliable policy and hybrid governance model can be established while ensuring the long-term sustainability of resources to support sustainable, regional development.

Research Methods and Outcomes

The study adopts an on the ground, multidisciplinary methodology, incorporating first hand accounts as well as on-site testing of agricultural and energy data from participating farms. The Habiba Community is analyzed to identify successful community led strategies, programs and activities to define the best practices and co-creation methodologies used in the 100 farm sites, as well as their many incubators and pilot projects. The research process for the Moghra case involves an international review of technology trends and financial models to identify and characterize best practices from the present to 2025. This includes

analyzing community size, economic activities, local wind and solar resources, agriculture type, external linkages, distance from the coast and operational management. The assessment also evaluates the innovation potential from 2025 to 2035, considering investment and operational costs, modularity and flexibility in system size, and the robustness and lifetime of the technologies. Finally, the lenses of Theory of Access and Hybrid governance, the paper analyze the practices that led to each cases respective successes as well as their hybrid governance strategies as they endeavor to upscale and potentially collaborate. Together, the documentation and hypotheses provided by the seed case studies will be formulated into a policy guide that can be applied on the regional, national and multinational scale for sustainable development.

Conclusion

The project aims to coordinate and enhance existing research efforts by documenting findings and evaluation results on the ground. The research process involves various activities such as stakeholder analysis, socio-spatial research, social infrastructure analysis, narrative research and exploration of energy and water technologies. This collectivized research will be presented in the paper as a **detailed guidance tool**. This research provides guidelines for coastal regions worldwide seeking to navigate the complex challenges posed by climate change and promote inclusive and sustainable development with both top-down and bottom-up approaches. The outcomes and insights gained from this project hold relevance for arid and desert communities globally.

Acknowledgements

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CWW2023 – CAIRO
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Sewage Sludge Disposal and Management: How to Turn Problems into Opportunities

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Keywords: Livestock wastewater; Liquid fertilizer; Microbial nutrient recovery cell; Macronutrients recovery; Sludge reject water.
CWW2023 Theme: 5

Abstract

The challenges of water scarcity and pollution, along with restricted resource accessibility, have been significant issues confronting our society for the last century. These challenges are expected to escalate to an unprecedented degree in the next few years [1, 2]. The escalating global demand for fertilizers, which experiences an annual growth rate of 4% [3], has compelled the retrieval of macronutrients, including nitrogen, phosphorus, potassium, magnesium, and calcium, from waste streams to meet the global food requirements. This is due to the fact that the current methods of supplying chemical fertilizers are not environmentally viable [4]. In recent decades, various techniques have been employed to facilitate the effective retrieval of nutrients from organic waste streams. These methods include ammonia stripping, electrodialysis, and membrane-based technologies. Although the recovery of nutrient and value-added products from wastewater using advanced technologies is highly efficient, their widespread application is hindered by the associated high costs, including energy consumption and chemical requirements [5, 6].

The anaerobic digestion process is a mature technological approach for the stabilization of sewage sludge and renewable energy production (i.e., methane-rich biogas) [7]. However, the anaerobic digestion of sludge leads to a significant increase in ammonia concentration, which can be attributed to the hydrolysis of proteins and subsequent fermentation, resulting in an ammonia-rich liquid waste stream (i.e., sludge reject water) with an ammonia concentration of up to 1 g-N/L [8]. Sludge reject water, which its volume is approximately 1–3% of the incoming wastewater flow, is usually recycled and mixed with the treatment plant influent, imposing a high ammonia load on the wastewater treatment plant, which requires high energy demand for its removal through conventional nitrification and denitrification process (i.e., ~ 45 MJ kg-N $_{\text{removed}}^{-1}$) [9, 10]. Although sludge reject water contains relatively high levels of nitrogen and phosphorus, it is characterized by low levels of readily biodegradable organic matter and alkalinity. This presents a significant challenge for its use as the sole donor substrate for bioelectrochemical nutrient recovery, as noted in previous research [11].

In this study, we designed and operated self-powered a microbial nutrient recovery cell (MNRC), which has been developed to attain optimal nutrient recovery while simultaneously minimizing the energy and chemical demands associated with nutrient recovery [12, 13] (Figure 1). The MNRC relies on the distinctive ability of electroactive

bacteria (EAB) to convert various waste streams into electric current, thereby facilitating self-powered ions migration and recovery through ion-selective membranes. This results in energy-efficient and sustainable technology for wastewater purification and recovering value-added products [14, 15]. More specifically, we investigated how the addition of high-strength livestock wastewater could improve the macronutrient recovery from sludge reject water into a liquid concentrate/fertilizer. Real sludge reject water samples were collected from the Gabal Al-Asfar wastewater treatment plant (Cairo, Egypt). Table 1 shows the main characteristics of sludge reject water. Livestock wastewater was collected from a local cows farm (Sharkia, Egypt), which contains feces, urine, and washing water. Prior to the use of livestock wastewater, it was sieved to remove large solid debris. The high-strength livestock wastewater had a dark greyish-black color with a high organic matter concentration (11960 ± 807 mg COD/L), total suspended solids (3465 ± 2175 mg/L), total dissolved solids (10490 ± 290 mg/L), and high buffering capacity (pH = 8.1 ± 0.3 and total alkalinity (as $CaCO_3$) = 12550 ± 900 mg/L). Throughout our study, we used both wastewater streams without dilution, pH adjustments, and the addition of trace minerals and/or nutrients.

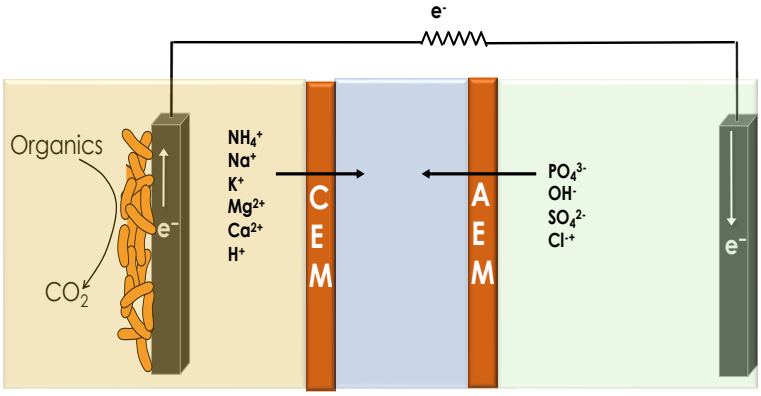

Figure 1. Schematic diagram of microbial nutrient recovery cell used in this study

Table 1. Characteristics of sludge reject water used in this study (average ± standard deviation)

Parameters	Unit	Sludge reject water
pH	-	8.0 ± 0.4
Chemical oxygen demand	mg/L	274 ± 38
Total suspended solids	mg/L	368 ± 58
Volatile suspended solids	mg/L	244 ± 16
Ammonia (NH_4^+-N)	mg/L	310 ± 59
Phosphorous (PO_4^{-3})	mg/L	4.87 ± 1.9
Calcium (Ca^{2+})	mg/L	133 ± 3
Magnesium (Mg^{2+})	mg/L	168 ± 9
Potassium (K^+)	mg/L	487 ± 110
Sodium (Na^+)	mg/L	377 ± 50
Chloride (Cl^-)	mg/L	910 ± 120
Sulfate (SO_4^{2-})	mg/L	145 ± 50

MNRCs that were supplied with sludge reject water demonstrated a modest current density production of 0.98 ± 0.31 A/m^3, along with a reduction in chemical oxygen demand (COD)

concentration of approximately 24 ± 2%. The removal of NH_4^+ was found to be 37.1 ± 11% with an up-concentration factor of approximately 0.43 ± 0.15. The optimization of macronutrient recovery and up-concentration, specifically NH_4^+, PO_4^{3-}, Ca^{2+}, K^+, and Mg^{2+}, was achieved through the utilization of a mixture of sludge reject water and livestock wastewater. The content of the livestock wastewater ranged from 10 to 30%. The results indicate a significant increase in both the current output and NH_4^+ up-concentration factor, with peak values of 14.10 ± 1.14 A/m^3 and 2.19 ± 0.51, respectively, observed in MNRCs that were supplied with a mixture of sludge reject water and livestock wastewater in a ratio of 70%:30% (v:v). A comprehensive examination of the liquid concentrate indicated that it has the potential to serve as an effective liquid fertilizer, capable of substituting chemical fertilizers while maintaining comparable agricultural productivity at a reduced expense (Figure 2). Our research study sheds light on the correlation between the presence of organic matter in waste streams and the potential for macronutrient recovery and up-concentration in self-sustaining, chemical-free MNRCs that are supplied with low-strength waste streams, such as sludge reject water. Furthermore, a significant inference that can be drawn from our study is that retrieval of the majority of NH_4^+ present in the sludge reject water would result in a reduction of expenses and energy consumption associated with the existing techniques employed for NH_4^+ elimination (nitrification/denitrification) in traditional wastewater treatment facilities, particularly when the sludge reject water is reused and blended with the influent of the treatment plant.

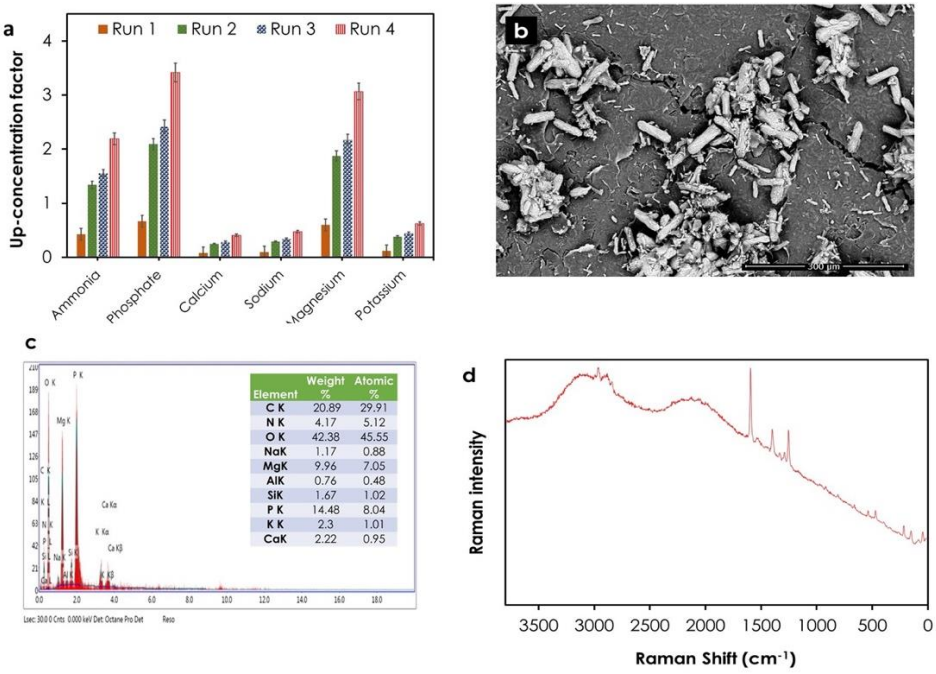

Figure 2. (a) Up-concentration factors for macronutrients at the end of six consecutive operational cycles for the MNRCs, (b) SEM image, (c) EDX spectra, and (d) Raman spectra of the crystal developed at the cathode surface of MNRCs.

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Precise Crop Irrigation Requirements and Scheduling Using Remote Metrological Stations & Soil-Heat Sensing technique (CORDOVA)

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Keywords: Precise Crop Irrigation, Metrological Stations, ETA, Irrigation Scheduling.
CWW2023 Theme: 5

ABSTRACT

Rough estimates of crop water consumptions and irrigation requirements are often used based on approximated weather conditions and evapotranspiration values. This is due to the cost and complexity of using local weather stations and soil sensors. The advanced CORDOVA- ET system enabled simultaneous evapotranspiration monitoring through the COnductance Recording Device for Observation and VAlidation of ET [CORDOVA-ET]. This system enables also determination of water consumptions, irrigation requirements, as well as calibration of the remote sensing ETA, estimation at field pilot level. CORDOVA-ET multiple micro- metrological station nodes were installed in the experiment's farm, El Minia Research station, WMRI, NWRC. Our objectives were to: Compare the irrigation requirements and scheduling based on CORDOVA-ET System, with those estimated from the traditional reference recommendations, or those estimated by the nearest weather stations. In addition to applying the continuous ETA system for reliable crop-consumption and irrigation scheduling adjustment. The pilot farm was allocated for water management and water use optimization researches, with cooperation with FAO, IIP Directorate, and El Minia Agricultural Services Directorate. Experiments were implemented during a successive agriculture year 2022-2023, while this phase is an inception for assessment of crop-water use efficiency, on farm irrigation efficiency, and scheduling, in regard with the accurate precise irrigation consumptions and requirements. Results had shown diversion of water use efficiency of the conventional irrigation from precise optimized water use. Considerable enhancement of WUE had been observed due to application of the hybrid irrigation system (Gated Pipes) based on precise irrigation requirements. The preliminary results can be used as a reference for crop-consumptions, that can be applied for the regional scale. Relative water saves can be achieved by applying precise irrigation, with high return in both crop productivity, and soil-environmental conservation.

General: Digital alteration in the agricultural sector is considered one of the priorities to face the various challenges of water and farm management (Foley et al., 2011, Tilman et al., 2011 and Mueller et al., 2012). Water conservation has recently received much attention, especially in the US, where extensive growth coupled with drought conditions has, recently, reduced the amount of water available for irrigation (Ervin and Koski, 1998, Kjelgren et al., 2000). Precise agriculture mainly aims to facilitate on-farm actions and decision-making, based on data from accurate instrumentation or remote sensing, on geography, topography,

climatic, soil, and surrounding environment. Clement Atzberger, 2013 concluded that agriculture depends strongly on the timeliness of the provided information, for agricultural developments. Precise agriculture is characterized as an effort to improve the results of practical farming, achieving higher profits by exploiting the existing spatial unevenness (Vrchota et. al., 2022). The precise irrigation was discussed by Camp et al. (2006) and Sadler et al. (2007), and presented by Pierce (2010), that can be defined as a technique based on the principles of agriculture, soil, and metrology to provide each area with its particular water supply requirements.

Methods and Discussions:

Conductance Recording Device for Observation and Validation of ET (CORDOVA-ET) System, was used to precisely adjust water consumption and irrigation scheduling. The System is composed of multiple micro-meteorological stations (nodes) with soil sensors. The nodes are powered with solar photovoltaic cells and operate with batteries. Then data is forwarded to the Internet from the base station (through gateway). The base station can receive data from the nodes in a range of about 10 km, depending on the topography, and antenna location. Figure (1) illustrates a schematic diagram of CORDOVA system, while figure (2) presents a comparison between ETa obtained from CORDOVA and remote sensing metrological data. Moreover, the system is feasible, produced with local components, and can be up-scaled at regional level, to adjust irrigation activities, and support water management decision-making on both on-farm and off-farm levels.

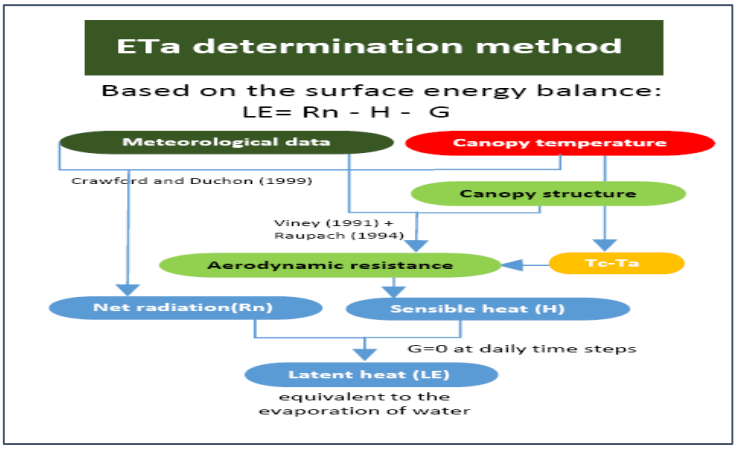

Figure 1. Schematic diagram of the CORDOVA system

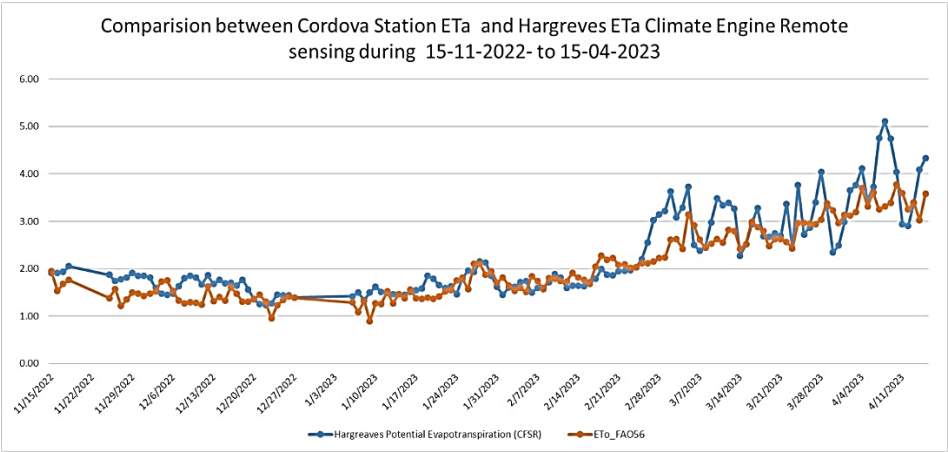

Figure 2. Comparison between CORDOVA system & (Climate Engine; Hargrives') results.

Results

To assess validity of the new applied system; water consumption obtained from the weather stations' data (ETo), was compared with "CORDOVA" system's results, and data availed from Climate Engine. Then verified data were applied to simulate volumetric soil water content (*WS*), within the root-zone. The corresponding timely conduct precise irrigation consumptions was compared to conventional irrigation consumptions, and scheduling. Thus, CORDOVA system circuitry along with soil-moisture monitoring, enabled irrigation adjustment, by allowing reasonable irrigation scheduling, to operate based on the estimated soil water content (*WS*). Meanwhile, practical use of CORDOVA system requires inputs of water system hydrology, and farm boundary conditions, along with estimates of evaporation, transpiration, and irrigation.

Conclusions

- Precise estimation of crop-water consumption and irrigation requirements based on the metrological records and actual soil moisture is essential for enhancing irrigation efficiency and water productivity.
- The crop consumption and irrigation requirements Conducted based on “CORDOVA” was verified through comparison with both conventional and remote ETo techniques.
- Precise irrigation require application of controlled irrigation system (i.e. gated pipes), with provision of timeliness soil moisture, and soil heat data.
- CORDOVA system had shown good performance compared with the alternative techniques for predicted of crop-water consumption, optimized irrigation schedule (OIS), and adjusting water use efficiency.
- Application of CORDOVA remote weather stations' system permitted considerable water savings (>20%).

Acknowledgment

The authors would like to express sincere appreciation for FAO for providing the CORDOVA system to El-Minia experimental farm. We also do appreciate cooperation of the IIP, and El Minia Agricultural Services Directorates.

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The Effect of Deficit Irrigation on Water and Crop Productivity of Potato in Jenin Governorate - Palestine (Case study)

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Keywords*:* Deficit irrigation, Aqua crop, climate change, water productivity.
CWW 2023 Theme: 5

ABSTRACT

Palestine as other Arab countries in the region is located in the one of the arid and semi-arid areas in the world; most recent assessments have concluded that arid and semiarid regions are highly vulnerable to climate change (IPCC, 2007a).

Impacts significant to the region include decreased precipitation, significant warming and more frequent extreme weather events, the recent climatic studies indicated that the global surface air temperature increased from 1850 to 2005 by 0.76ºC. Moreover, the linear warming trend over the last 50 years is recorded by 0.13ºC per decade (IPCC, 2007b). Regarding the Arab countries, recent studies found that the Arab region experienced an uneven increase in surface air temperature ranging from 0.2 to 2.0ºC that occurred from 1970 to 2004 (IPCC, 2007a). These could lead to greater water scarcity and decrease agricultural productivity. Palestine expects that climate change will most severely affect water and agricultural sectors that will lead to higher insecurity levels for food and water.

Irrigation water availability consider one of the most important constrain facing the irrigation agricultural development in Palestine, according to PWA report (2018), the amount of irrigation water will decrease 20% to 25% in the coming 30 years, due to population growth, increase in the non-agricultural water demand and climate change conditions.

Potato crop consider one of the main field crops cultivated in Palestine mainly in Tubas and Jenin governorates. According to the ministry of agriculture statistics, the total cultivated area of irrigated potato was 10835 dunum, which means that 3.2% of total field crops of west bank was cultivated of potato, and the estimated annual productivity of potato was 37552 ton per year with 27% produced in Jenin governorate.

In cooperation with ESCWA, ACSAD, FAO the Ministry of Agriculture, carried out a simulation case study using Aqua Crop software in in Marj ben Amer plain in Jenin governorate which is located in the northern part of west bank, Marj ben Amer consider one of the most fertile internal plain in Palestine with total area of 361 Km^2, the cropping pattern are varies due to unique climatic conditions and availability of water resources.

The main objective was to study the impact of applying different deficit irrigation scenarios on productivity of the potato crop compared with the full irrigation scenario, to achieve the

objective, five deficit irrigation scenarios was applied, (80%, 70%, 60%, 50% and 40%) on crop and water productivity.

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To run the simulation model, detailed crop data was collected from the specialists of plant production and the collected data was verified by researchers from national agriculture research center (NARC), while soil data was collected from soil department from MoA, planting date was 1st of March, soil fertility was near optimal with 85% and the weeding control was 95%.

The result showed that the total crop productivity is 10.01ton/h, 9.48 ton/h, 8.74,ton/h,7.67ton/h, 6.59, ton/h and 5.07 ton/h for the full irrigation, 80%,70%, 60%, 50% and 40%, respectively, while the results of water productivity of potato is 1.85 kg/m3, 1.85 kg/m31.85 kg/m3, 1.78 kg/m3, 1.7 kg/m3 and 1.51 kg/m3for full irrigation 80%,70%, 60%, 50% and 40%) respectively.

The obtained results indicates that applying the deficit irrigation 80% and saving 20% of irrigation water reduced 5% of the yield, and water productivity was not reduced, while applying 70% of irrigation water and saving 30 %, reduced 13% of the yield, and water productivity was not reduced also, comparing with full irrigation, therefore, the second scenario by applying 70% and saving 30% of irrigation water consider the best scenario for crop productivity, as well as for water productivity.

It is worth to mention that the actual irrigation program is 15 mm/3days starting from the 1st day of Planting, while the average crop productivity is 8.5 ton/ha.

Below figures are the amount of irrigation water used comparing with water productivity (A) and the crop yield (B).

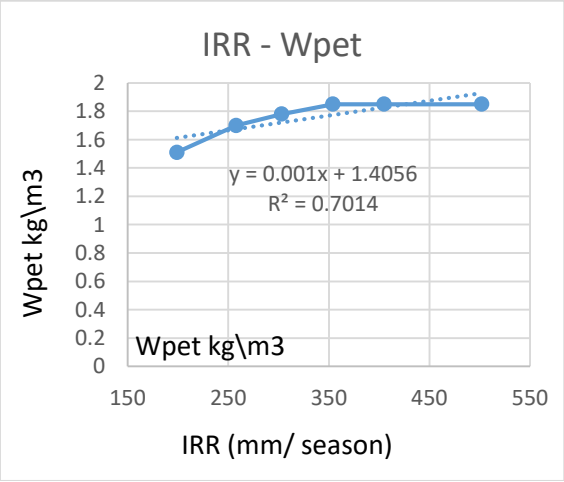

Figure A, Irrigation water and WP.

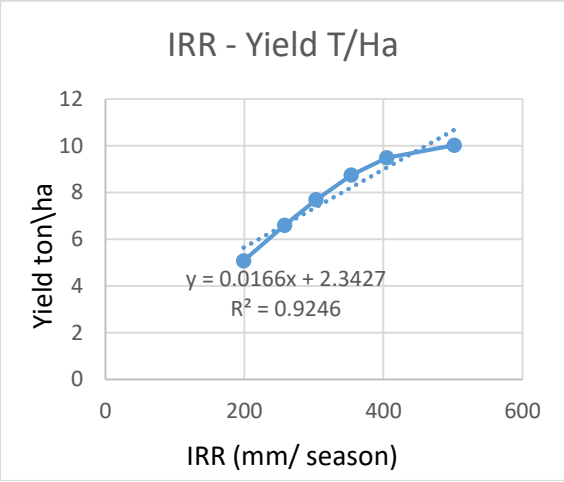

Figure B, Irrigation water and yield.

Due to the phenomena of climate change, water scarcity, irrigation water shortage, and results obtained from the simulation case study, it is highly important to follow the next recommendations to improve water productivity as well as save the irrigation water for other uses or expansion the irrigated area.

1. Encourage National Agriculture Research Center (NARC) to test several deficit irrigation scenarios on the main strategic field crops including the vegetables in order to optimize the quantity of irrigation water should be applied to reduce the water losses, increase the productivity and save water to increase the irrigated land.

2. Increase capacity building of the extension staff in MoA, Parallel with increase the farmers awareness to reduce the amount of irrigated water by irrigation according to crop water need considering climate, crop, and soil conditions.

Acknowledge
The others would like to express appreciation for the support of the sponsors project Number **0801619E.**

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Impact of SDG's on Sustainable Development in the MEANA Region

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Keywords: Sustainable Development, Sustainable Growth, SDG's, MEANA, Multi criteria, Participatory Approach.
CWW2023 Theme: 5

ABSTRACT

Most of the MEANA region countries still do not have clear sustainable development plans reflecting the SDG's and future sustainable growth. As a consequence, the prospects for future sustainable growth in these countries are uncertain. In addition, this will affect the sustainable development in the sectors lack such plans such as water and sanitation sectors. This paper aims at identifying the gaps in the current sustainable development plans in the MEANA region presenting the case of Jordan, Egypt, Morocco and how to bridge the gap between SDG's and current plans with minimum impact.

Water is identified as enabling resource in five other goals of the SDG. Consequently, unlike the MDGs, which were mainly focused on water supply and sanitation in relation to water under the heading of MDG7 (environmental sustainability), the independent goal under SDG with its proposed target areas of water provides for a significant increase in scope, opportunities and challenges.

The water-related targets provide countries with common goals, and are as important as benchmarks and standards for progress, not only as aspirations, but as tools to mobilize concrete actions. Countries and stakeholders need robust evaluation systems to track the effectiveness of their institutions and actions in delivering the expected outcomes of the SDG 6, the water goal, and measure what needs to be improved.

The approach used in this study is based on the outcomes of the carried workshops and meetings by the division of sustainable development (UN-DESA). The meetings with key ministries and organization responsible on water, sanitation and environment in Jordan, Egypt and Morocco were carried out the through period from 2015 to 2019. The discussions in those meetings focused on the actions implemented in those countries to achieve the SDG's related to those sectors.

In addition, the study reviewed the outcomes of publications by other UN organization to help the countries in implementing the necessary actions to achieve the SDG goals for the water, sanitation and environment sectors in those countries. For example, the Sustainable Development Report 2023.

The analysis of the workshops outcome showed that the three countries Jordan, Egypt and Morocco have general sustainable development plans in the political dimension and less linked with the following goals; water supply; sanitation; water quality and pollution; water use efficiency across all sectors; integrated water resources management; protection and restoration of ecosystems. This is mainly due to the needed high investment in the water,

and sanitation infrastructure from one side and the lack of urban and rural planning for cities and towns expansion.

However, the progress in the water and sanitation and environment SDG's is still need more efforts, the three countries showed progress in all SDG's. According to the 2023 Index Report; Jordan ranked 77, Morocco ranked 70, and Egypt ranked 81. The ranking reflects overall score measures the total progress towards achieving all 17 SDGs.

Another result; there is considerable evidence that achieving SDG 6 will bring significant economic benefits that exceed the investment needed. For water and sanitation alone, research shows that benefits exceed the cost of an intervention by 3 to 6 times. The economic return on sanitation spending is US $5.50 per US dollar invested. the estimates suggest that achieving universal access to basic water, sanitation could cost roughly 70% of countries public finance.

The progress towards the goals requires more planning and high investment in the infrastructure in those areas. This requires more coordination with international donors to improve the progress and countries international ranking in the overall SDG's. The three countries (Jordan, Egypt and Morocco) showed significant progress in the water, sanitation and environment planning and linking the plans with SDG's. However, in the next stage the focus should be on the technical part to define the impact on the goals , and sub goals level in the following areas.

- Water supply and customers satisfaction
- Wastewater collection and reuse
- Water quality and health risk from water related diseases
- Environment and ecosystem impact
- Stability in socioeconomic aspects
- Social protection floors tailored to national needs and capacities promoted
- Promotion of entrepreneurship and sustainable enterprise development

The main challenges facing the three countries are as follows;

First, to ensure that the countries take ownership of the development goals and align them with national priorities. This requires technical and political choices to strengthen the coordination of public policies.

Secondly, the need for monitoring-evaluation institutional framework,

Thirdly, the need for improved quality and quantity of data which will help the countries public authorities to monitor the progress, shortcomings and constraints in terms of achieving the SDGs.

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Potential of Water Desalination using Renewable Energy Sources in Arab Countries

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Keywords: Water Desalination, Renewable Energy, Solar Energy, Water-Energy-Food Nexus, Sustainability.

CWW2023 Theme: 5

ABSTRACT

The Arab region is one of the most water-scarce regions in the world, as many Arab countries have very low levels of water availability per capita. Dependence on desalination is imperative to meet the drinking water needs of more than 420 million citizens in the Arab region. In the Arab region, renewable energy has become the dominant trend, and over the past decade, investments in solar and wind energy projects have exceeded $17 billion. Desalination provides only about 1% of the world's drinking water, but this number is increasing year by year, and a significant increase in investments over the next few years is expected to lead to a tripling of capacity by 2030[1]. The largest market for this technology in the world is the Arab region, where countries in the region consume half of the desalinated water in the world. This study investigates the potential of water desalination using renewable energy sources in the Arab region. There is a clear commitment to adopting forward-thinking policies and capitalizing on the enormous value of renewables and connectivity across borders in addition to the presence of political will in the Arab region to promote water desalination with renewable energy considering water scarcity and increase the share of renewable energy in the energy mix. This can be shown through the commitment of all Arab countries to encourage investment in the renewable energy sector, which showed 400% increase from 2010 to 2016[2]. Simple investor actions, land allocation for renewable energy projects, and national targets for renewable energy can be examples of this government commitment, as most Arab countries have declared promising targets for renewable energy. The regional share of renewable energy has reached 7% of the total energy mix. Excluding hydropower; it is observed that PV technology accounts for 60% of the energy balance, proving its position as the preferred technology in the region. Figure 1 illustrates the proportion of each technology, excluding hydropower. Arab countries have one of the largest renewable energy potentials in the world, and therefore it is clear that they are making great strides to build competitive renewable energy markets[2].

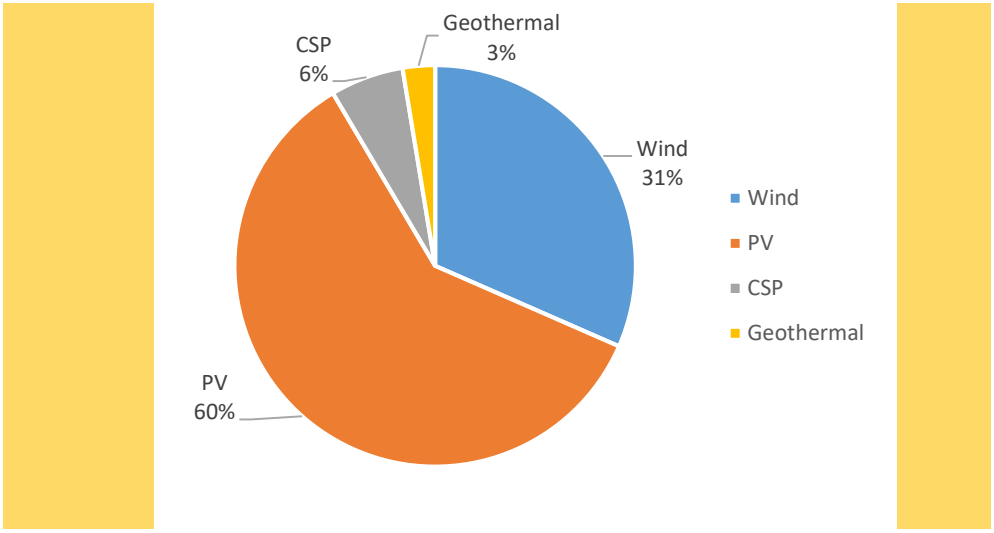

Figure 1: Renewable energy technologies shares (excluding hydropower) [2]

Future desalination systems will increasingly rely on solar, wind, and other renewable energy sources, taking climate protection objectives and environmental factors into account. Given that conventional energy costs are anticipated to rise in the near future and water availability is expected to decrease as a result of climate change, the future of powered desalination is uncertain[3]. Renewable energy technologies are becoming increasingly attractive to power desalination, a crucial issue for many countries in arid and semi-arid regions, such as the Arab region, where water costs are extremely high. Solar energy has the largest potential to be used in water desalination given its abundance in the region and declining costs[4].

As a result of advancements in both technology and energy efficiency over the 25 years, costs associated with water desalination have decreased by more than half, mainly reverse osmosis technology (range from 2.9 - 5 kWh/m^3, with an average of 3.5 kWh/m^3, and energy consumption accounts for almost half of the costs). The overall cost of desalination can be broken down into maintenance-operation cost (OPEX), which includes energy cost, maintenance, repairs, personnel/staff, spare parts, and reconstruction when necessary, and capital cost (CAPEX), which includes land, buildings, and equipment, as well as transportation cost, insurance, construction, legal fees, and unforeseen costs. For both thermal and membrane desalination processes, the cost of energy is the largest contributor to operational expenses and, consequently, to total costs. At present, for membrane desalination plants, CAPEX costs average from 0.65 – 1.2 million \$/100 m^3 per day, which is around 33% of total costs, while OPEX make around 66% of total costs, averaging at 0.5\$/m^3 for large plants with capacities from 100,000 – 500,000 m^3 per day. Energy costs can frequently account for up to 60% of OPEX[4], [5].

In the Arab region, water security, energy security, and food security are perhaps more intertwined than in any other region of the world. This interdependence between water, energy, food, and climate change in the Arab region necessitates a nexus approach and way of thinking when addressing the management of these three essential sectors. The nexus between water, energy, and food in the Arab region is influenced by numerous environmental, demographic, social, and economic factors, which not only intensifies their interdependence but also increases its hazards. Given the importance of the energy and water sectors, there are numerous threats and repercussions to their respective security. The cost

of energy inputs to water production will have the greatest effect on Arab countries, where water desalination plays an increasingly vital role, particularly in GCC nations. More than 50% of the total economic cost of desalination facilities is attributable to energy expenses.[6], [7]

Arab nations rely heavily on desalination of seawater and brackish water as well, and this dependence is projected to increase exponentially over the next decade due to climate change impact on water resources, and the salinization of aquifers. Water desalination can only be considered a viable adaptation strategy if we guarantee its proper design, minimize its environmental impact, and generate its electricity from non-fossil fuels. Arab nations must localize knowledge and technology in the field of renewable energy water desalination. The innovation of desalination rests not only in its technological aspect, but also in its potential to serve as a bridge between nations. As climate change and population growth continue to place pressure on Earth's limited water resources, we expect to make significant advancements in desalination and other water technologies to meet the growing global demand for water in our Arab countries.

Acknowledgment
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Estimating Water Erosion in the EL-Mador Valley Basin, South-West Matrouh City, Egypt, Using Revised Universal Soil Loss Equation (RUSLE) Model through GIS

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Keywords: Water Erosion, Risk Assessment, RUSLE, Geographic Information System, Remote Sensing, EL-Mador valley basin, Egypt.
CWW2023 Theme: 5

ABSTRACT

Water erosion is among the largest and most crucial problems with soil loss and that is through land degradation in semi-arid regions and the North African areas are especially vulnerable to it. In addition, the EL-Mador Valley Basin is exposed to soil degradation due to climate and topographic properties as well as a human activity. In this scope, the aim of this study is to perform an evaluation of soil degradation hazards in the EL-Mador valley basin by employing the equation RUSLE and the data of Remote Sensing (RS) within a frame Geographic Information System (GIS). Furthermore, various raster layers have been designed to RUSLE parameters such Rainfall Erosivity (*R*), Soil Erodibility (*K*), Topographic (*LS*), Crop Management (*C*), and Conservation Practices **(***P)* these inputs were merged into a GIS-based framework for measuring the degree of soil degradation. The results demonstrate the ranged values from 0 to >2500 ton ha^{-1} $year^{-1}$, with a geographical average of 54.80 ton ha^{-1} $year^{-1}$. In addition, a soil erosion hazard map was created which was divided into five hazard categories: Low (56.56%), Moderate (13.88%), High (8.09%), Severe (8.82%), and Extreme (12.65%). Moreover, these results will be important to create mitigation strategies for regions where the soil loss is high, severe, and extreme. In addition to assisting the local administration in setting priorities and basis for decision-makers to create suitable actions to decrease soil erosion hazards.

Introduction

Water and soil are both important components where water erosion causes significant quantity and quality damage in dry regions; it leads to the degradation of the pedological surface layers and the movement of its contents ingredient reducing agriculture output and causing water quality degradation [4]. However, there are a number of studies that suggest that the Mediterranean region is vulnerable to climate change, with rising aridity speeding up erosion caused by water [1]. Therefore, Water erosion is essentially the outcome of the mismanagement and depletion of natural assets, mainly from unfit farming techniques, and overgrazing [2]. The main goal of that research is to measure the annual rate of soil loss and determine its geographical distribution in the EL-Mador Valley basin using the RUSLE model through GIS. As a result, soil protection measures must be implemented to limit the risk of water erosion and different soil management strategies should be prioritized in agricultural areas particularly on steep slopes. Meanwhile, the resulting soil loss map is an

essential requirement for quick usage by local decision-makers for soil management planning.

Study area

EL-Mador valley basin is located in southwest Matrouh City, northwestern coast of Egypt. the study area extends between latitudes 31° 12 ′ 25"- 31° 22 ′20" North and longitudes 27° 2′ 30" - 27° 10 ′ 30" East, It cover an area of approximately 105.61 Km^2 (Figure 1). This basin bordered Wadi El-Raml to the east, the Wadi Maged to the west, the plains lands to the south, and the Mediterranean Sea to the north.

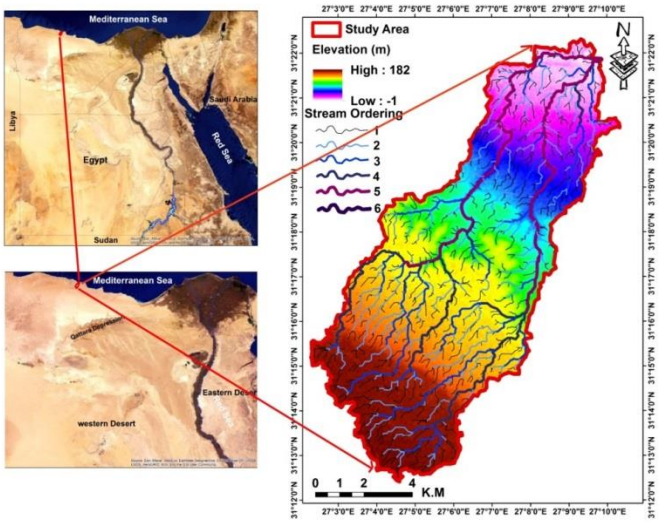

Figure 1 Site map of EL-Mador Valley Basin

Materials and Methods

The study uses a variety of spatial datasets from multiple sources to achieve its goals. Table1 illustrates the datasets and their related sources. Therefore, these data are combined and calculated using the Geographic Information System, Remote Sensing, and RUSLE for the mapping of the areas vulnerable to estimation soil water erosion.

Table 1 Information about the data utilized in this study.

No.	Type of data	Format	Factor	Description	Source
1	DEM (SRTM)	Raster(.tiff)	Ls,p	Spatial Resolution 30×30m	(USGS data) https://earthexplorer.usgs.gov
2	Satellite image (Landsat8)	Raster(.tiff)	C,P	Spatial Resolution 30×30m	Landsat 8OLI/TIRS(USGS data) https://earthexplorer.usgs.gov
3	Rainfall Data (TRMM)	Raster(.tiff)	R	Spatial Resolution 30×30m	European Soil Data Centre(ESDAC) https://esdac.jrc.ec.europa.eu
4	Soil data	Vector+Excel (.shp+.xls)	K	1:5.000.000scale	Digital Soil Map of the World(2007) https://data.apps.fao.org/map/catalog

Results and Discussion

In the present assessment, Figure 2 showed the annual rate of water soil erosion risk in the EL-Mador Valley Basin ranged from 0 to >2500 ton ha^{-1} year^{-1}, with a spatial average of 54.80 ton ha^{-1} year^{-1}. In this scope, the raster output of water soil erosion was divided into five hazard categories: Low (56.56%), Moderate (13.88%), High (8.09%), Severe (8.82%), and Extreme (12.65%) as shown in Table 2.

Table 2 Classification of water soil erosion in EL-Mador Valley Basin.

Erosion Description	Soil loss classes in ton ha^{-1} $year^{-1}$	Area (km^2)	Percentage (%)
Low	0-5	59.73	56.56
Moderate	5-10	14.66	13.88
High	10-20	8.54	8.09
Severe	20-50	9.02	8.82
Extreme	>50	13.66	12.65

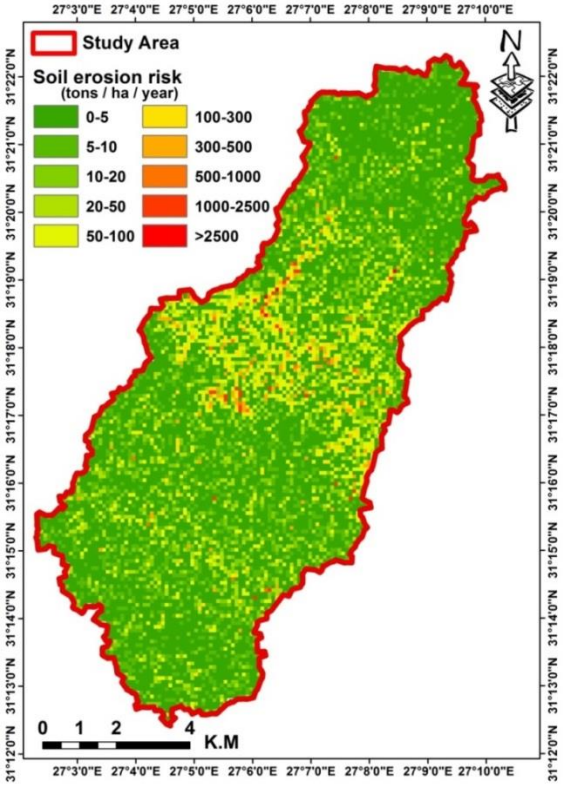

Figure 2 Distribution map of soil erosion values in EL-Mador Valley Basin

Conclusions

Water erosion is a popular occurrence that has a negative impact on the land. Water erosion refers to a loss of production caused by nutrient loss, a reduction in soil thickness, and in severe circumstances, full soil loss. As a result, it's essential to evaluate the erosion's possible in order to take preventative actions against damages [3]. In addition, Water erosion is difficult to prevent, but it can be decreased with appropriate land use management and support techniques that can stabilize the area's topsoil. In this study, the RUSLE model merged with remote sensing and geographic information system was utilized to estimate average annual soil erosion in the EL-Mador Valley Basin for the purpose of evaluating soil erosion and protecting soil and natural resources. Where, this study reveals that the annual rate of water soil erosion risk in the EL-Mador Valley Basin ranged from 0 to >2500 ton ha^{-1} $year^{-1}$, with a spatial average of 54.80 ton ha^{-1} $year^{-1}$. Hence, the data on soil erosion in the study area will assist in the prioritization of soil conservation strategies.

Conflict of Interest:

The author declares that has no conflict of interest.

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Low-Cost Removal of Some Commonly Used Pesticides from Polluted Groundwater Using Charcoal from *'Salix Mucronta'* Trees Activated by Gold Nitrate

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Keywords: Wastewater treatment, pollution, groundwater, agricultural pesticides, adsorption, activated charcoal/carbon.
CWW2023 Theme: 5

ABSTRACT

Pesticides are used to protect agriculture from pests. Precautions are made to control pesticide residues down to permissible limits in crops, fruits and stalks to protect humans and animals. However, pesticides that fall down on the field ground may reside in the soil for up to 12 weeks and leak with percolation to groundwater, endangering human and animal health.

This work examines the use of a new cheap material for removing four of the most commonly used pesticides from polluted groundwater before use for drinking. Charcoal obtained from the trunk of *Salix Mucronta* trees ("As-Sefsaaf Al-Baladi") is introduced for removing these pesticides by chemical adsorption on its surface. Four of the most commonly used pesticides in Egypt were selected to conduct this study [1, 2]. Charcoal activation treatment uses gold-nitrate solution. Positively charged gold metal ions bond with the charcoal surface negatively-charged parts, break them off surface compounds, and remove them with leaching. This generates surface pores and cavities of exposed positively charged parts (called functional groups), enhancing the activated charcoal adsorption capacity. This use of gold nitrate is at low cost using about 0.1 g gold/Kg charcoal. Furthermore, the activation solution can be collected and re-processed to re-use the gold molecules.

The physical and chemical properties of concern for the studied pesticides were determined. The abundance of pores of different sizes on the charcoal surface, which are generated by the activation treatment, is the main driving force for the high adsorption efficiency. The surface area of the activated charcoal and the active surface groups were studied using: (1) "Brunauer, Emmett and Teller" and "Barrett-Joyner-Halenda **(BET/BJH)** Analysis" [3]. (2) "Scanning Electron Microscope **(SEM)**" [4]. (3) "Fourier Transform Infra-Red **(FTIR)** Spectral Test" [5]. (4) "Thermo-Gravimetric Analysis **(TGA**)" [6].

Batch experiments were conducted to test some factors affecting the activated charcoal performance in order to reach the highest adsorption capacity. This included the dose (weight) of the charcoal, the initial concentration of the pesticide in solution, the contact time between charcoal and the polluted solution, and the polluted solution pH. Adsorption isotherm curve-fitting analysis was done using Langmuir model. This is because chemical analyses can only determine the concentration of pollutants remaining in the treated solution. If the calculated pollutants' mass that go out of the solution fit the adsorption isotherm curve, it is then an indication that the charcoal successfully adsorbed the pollutant [7].

Fixed-bed column experiments were conducted for the four pesticides to test the performance of the activated charcoal on treatment under steady flow. Further experiments were done to examine the effects of variations of parameters.

Experimental results of **BET/BJH** analysis showed that 0.1 N of gold nitrate treatment solution is optimal, which yielded surface area of 3050 m^2/g and pore volume of 1.55 cm^3/g. **SEM** test showed abundance of roughness all over the activated charcoal surface, while stepwise zooming-in (5,000X – 30,000X) ensured the consistent existence of pores and cavities at all scales on the activated surface. **FTIR** test should pulses that signal the existence of the functional groups on the surface. **TGA** analysis reveal reliable thermal stability of the surface compounds.

Batch experimental results show that contact times within, 120 minutes were sufficient for the four pesticides to reach equilibrium with the activated charcoal. pH nearest to 7.0 was best for charcoal performance. Variation of adsorbent (charcoal) doses achieved the highest adsorption capacities of 45.3, 100.6, 174.3 and 160.3 mg/g, for pH 7.0 and initial concentrations of about 30.0 mg/l. Meanwhile, highest value of initial concentrations of about 50.0, 44.0, 42.0 and 41.0 mg/l, respectively, reached highest pesticide removal. Adsorption isotherm studies using Langmuir model showed successfully the linear behavior for adsorption of the four pesticides.

For fixed bed columns (25 g charcoal, 50 ml water, 20 cm diameter, 30 cm height; 30.5 cm^3/min; pollutant's conc. 3.0 – 20 ppm; up to 5 hours); it took about 3.0 hours for all the pesticides at all concentrations to clean the polluted solutions down below the permissible limits for use in drinking water. Further fixed bed experiments provided more data that can be used in practical use.

In conclusion, this new material is cheap and effective in removing the studied pesticides from polluted groundwater and is recommended for practical use. It can be used at different levels at the national scale, including specially-designed small and/or portable treatment units for rural communities with limited/modest facilities/services.

Table 1. Fixed Bed Column 1st Experiment for steady flow clean-up

Pesticide	Initial Conc. (ppm)	Concentration after treatment (ppm)				Maximum Permissible Level (ppm)
Contact Time (hr.)	**0 hr.**	**0.5 hrs.**	**1.0 hrs.**	**3.0 hrs.**	**5.0 hrs.**	
I. Malathion	**3.51**	0.851	0.013	0.004	0.002	**0.018**
	7.86	1.213	0.021	0.009	0.009	
	15.08	2.08	0.235	0.014	0.013	
II. Methomyl	**2.09**	0.521	0.024	0.002	0.001	**0.055**
	4.53	0.824	0.032	0.004	0.003	
	17.41	2.895	0.384	0.003	0.003	
III. Abamectin	**3.03**	0.569	0.035	0.010	0.012	**0.020**
	7.46	1.154	0.081	0.009	0.009	
	11.80	2.812	0.235	0.013	0.011	
IV. Thiamethoxam	**3.65**	0.620	0.014	0.009	0.009	**0.136**
	7.72	1.954	0.067	0.003	0.004	
	18.43	3.021	0..413	0.008	0.006	

Shaded results are below Maximum Permissible Level; i.e. successful treatment.

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Irrigation Water Management Supply and Demand in Eocene Area Using Remote Sensing, Pysebal model and Ground Measurement

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Keywords: Pysebal, Water productivity, Remote sensing, WaPOR, Crop map and Actual evapotranspiration.
CWW2023 Theme: 5

ABSTRACT

Agricultural water (supply and demand) represent one of the main water accounting components for a specific area. It is playing the main role in agricultural development in Palestine, according to PWA report (2018), the amount of irrigation water will decrease 20% to 25% in the coming 30 years, due to urbanization growth, climate change and controlling the Palestinian land and water resources by Israeli occupation.

The research study was conducted under the regional project (water efficiency, productivity and sustainability) which was funded by Swedish International development cooperation Agency (SIDA) and implemented from 2018-2022 in The Eocene Aquifer which is located in the northern part of the West bank and extends to the north of the Green Line (Armistice Line). The total area of the aquifer is 543 km^2, 459 km^2 (84.5%) of which is located within the boundary of the West Bank, it is highly populated with more than 236,000 inhabitants living in 57 communities located in three governorates Nablus, Jenin and Tubas (PWA, 2022). The main objective of the study is to estimate water demand, supply and consumption in agriculture for better water management and productivity.

To achieve the objective, remote sensing was used to produce an annual and seasonal crop maps, as well as calculate Actual evapotranspiration (ETa). The annual crop map was extended from June to May next year (12 months) for olive trees, citrus and stone fruit trees…etc., while the seasonal crop map for Winter and Spring crops which extends from November to May of the next year such as wheat, barley, Onion, squash, cucumber cauliflower and cabbage.

Actual evapotranspiration (ETa) which is the amount of water actually removed from a surface due to the processes of soil evaporation and plant transpiration, was calculated using WaPOR data, and Pysebal module which is depend on satellite images of the area and climatic, dem and soil data.

Irrigation water demand was estimated based on crop type, climatic conditions and FAO crop coefficient, while the Crop water requirement was calculated using CROPWAT software based on modified penman Monteith equation.

The results indicated that, the total area is143.8 km^2 and 264.7 km^2 for irrigated and rainfed respectively, and the amount of water demand is 42 MCM and 169.8 MCM for irrigated and rainfed respectively as shown in details in table (1) and table (2) while the irrigation demand according to modified penman Monteith equation, was estimated at about 21.357 MCM without irrigation systems efficiency and 28.5 considering the 75% as irrigation efficiency (ARIJ 1999), while the total measured pumped irrigation water in Eocene according to AbuSaada 2021 was estimated 37 MCM.

The ETa was estimated about 37 MCM using Pysebal model, while it was calculated 42 MCM as shown in details in table (1), Which means there is a gap in irrigation requirement about 5 MCM.

Table 1. Net irrigation requirement, demand and consumed for irrigated crops, season 2020 -2021.

Crop type	Area (dunums)	Planting date	harvesting date	ETc (m3)	Irri req (m3)	ETa/m3/season Pysebal	ETa/m3/season Wapor
Cabbage	23,290	1-Oct	31-Dec	3,455,365	775,557	2,137,571	2,145,135
Cauliflower	28,110	1-Oct	31-Dec	4,170,473	936,063	2,575,339	2,585,213
Citrus	12,220	1-Jan	31-Dec	10,604,052	5,544,972	9,849,320	8,651,760
Green houses	9,710	15-Aug	30-May	5,356,036	5,356,036	5,357,395	5,357,395
Potato	15,390	1-Oct	30-Jan	3,139,314	1,185,030	1,839,422	1,839,987
Squash (Autumn)	14,200	1-Sep	30-Nov	3,252,986	608,946	2,037,413	2,046,118
Cucumber	25,460	1-Feb	30-May	7,440,407	4,079,687	8,478,180	8,249,040
Squash (Spring)	15,500	1-Feb	30-May	4,917,305	2,871,305	5,254,500	5,270,000
Total	**143,880**			**42,335,938**	**21,357,596**	**37,529,140**	**36,144,648**

Table 2. Rainfed agricultural demand and consumption, Season 2020 - 2021

Crop type	Area (dunums)	ETc (m3)	ETa/m3/season Pysebal	ETa/m3/season Wapor
Olive	42,440	35,169,816	34,715,920	30,556,800
Onion	12,160	4,839,984	3,793,920	3,757,440
Radish	17,130	1,266,849	719,460	822,240
Forest	16,600	12,773,742	12,367,000	12,018,400
Shrubs	90,000	79,852,500	64,143,000	62,100,000
mixed trees	17,100	13,360,931	12,072,600	11,610,900
Tobacco	13,800	5,407,013	6,789,600	5,354,400
Vetch	15,050	4,212,834	5,101,950	4,665,500
wheat	40,460	12,922,035	12,910,232	12,894,009
Total	**264,740**	**169,805,703**	**152,613,682**	**143,779,689**

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It is clear that, the actual applied irrigation water exceeds the optimal quantities by 30%. This highlights the importance of extension services role in the Ministry of agriculture to reduce the losses and improve the water productivity of main crops which was calculated mainly under this project (water Productivity component), Rainfed olive, date Palm, cucumber and Potato, and it was (0.31 kg/m^3), (kg/m^3), (kg/m^3) and (6.57 kg/m^3) respectively, thus the following recommendations are important to conduct comprehensive research to cover all Palestinian land for better water management and to increase productivity as well as the area of the irrigated land.

1. The study highlights the importance of institutionalizing Water Accounting in Palestine.
2. All the results of Water accounting should be linked with Governance and translated into strategies and actions.
3. Measures to optimize the applied irrigation water should be implemented, to reduce the water losses, increase the productivity and save water to increase the irrigated land.
4. Increase capacity building of the farmers to reduce the amount of irrigated water by irrigation according to crop water requirement.

Acknowledge
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Eco-Friendly Management of water hyacinth for Water Sustainability in Egypt

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Keywords: Water sustainability, Water hyacinth, Eco-friendly management, Remote sensing, GIS, SWOT.
CWW2023 Theme: 5

ABSTRACT

Egypt is facing a severe water scarcity crisis, with an annual water deficit of around seven billion cubic meters [1]. One of the major challenges is the uncontrolled growth of water hyacinths, an aquatic plant that obstructs waterways and impacts clean water availability. Water hyacinths thrive in nutrient-rich environments, forming dense colonies that hinder navigation, block drainage, cause flooding, and impede irrigation. In Egypt, water loss by evapotranspiration from water hyacinth infested areas is 3.5 billion m3/year, enough to irrigate 432 km2 annually [2]. Water hyacinths can negatively impact water quality by reducing dissolved oxygen levels, increasing nutrient concentrations, and altering pH levels [3]. Factors such as climate change, population growth, and land use changes exacerbate the problem. Consequently, the Egyptian government and local communities are concerned about the financial burden of controlling and managing water hyacinths.

A study was conducted to develop an environmentally conscious approach for managing water hyacinth in Egypt. The study focused on incorporating geographic information system (GIS) and remote sensing (RS) techniques to achieve effective control over this plant species. Remote sensing techniques provide a suitable solution for mapping and monitoring water hyacinth at different scales, offering timely and accurate assessments of species distribution by providing information on land cover and land use types. The study also explored the potential utilization of water hyacinth as a renewable resource for producing various goods and assessed the feasibility of this approach.

The study examined areas affected by water hyacinth in Kafr El-Sheikh, Ismailia, Suez, and Fayoum governorate, using field surveys and satellite images from Planet Scope. The study used the Normalized Difference Vegetation Index (NDVI) technique and GIS & RS to assess the spatial distribution, extent, and dynamics of water hyacinth invasion. The satellite images were taken for the months of May and July from 2020 to 2023 (Fig. 1), with a spatial resolution of 3 meters.

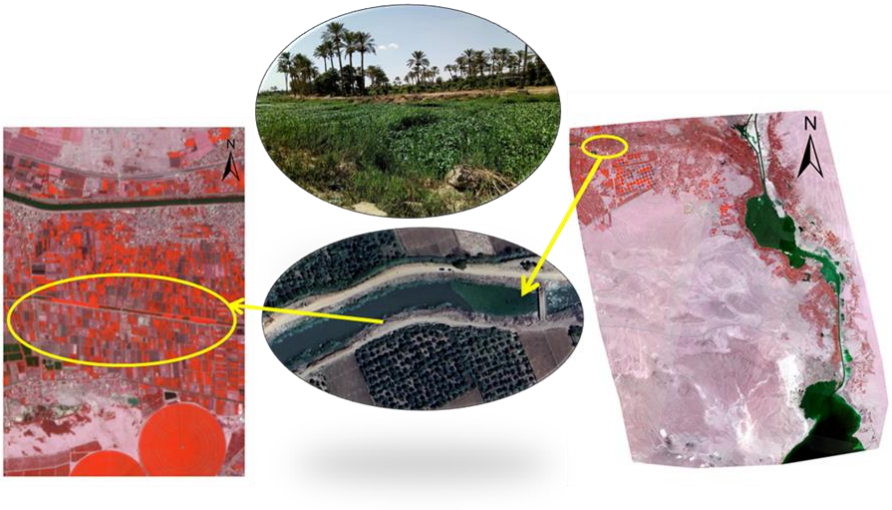

Fig.1. Satellite images showing progressive invasion of water hyacinth on Masraf Al-wadi, Ismailia Governorate in 12 May. 2023 (Image source: Google Earth and Planet Scope)

Fig.2. Water hyacinth plant pot is available on the IKEA website for EGP1,799

Different methods have been used worldwide to control the growth of water hyacinth, a highly invasive aquatic plant. Mechanical control involves using machinery and human labor, but it is expensive, especially for impoverished tropical countries like Nigeria, where it costs $9,500 per square kilometer [4]. Chemical control is a cheaper option, estimated at $183 per square hectare in the United States [5], but it faces public resistance due to the ecological and human risks associated with introducing chemicals into water. Biological control presents an alternative, using natural predators like the weevil species Neochetina eichhorniae or fungi like Alternaria eichhornia [6], but it carries the risk of unintended harm to non-target organisms. Some countries have found economic uses for water hyacinth, such as fertilizer production, fodder, biogas, briquettes, furniture, handicrafts (Fig. 2) , and water waste purification through phytoremediation processes, but developing countries face challenges in exploiting these opportunities due to limited technology and market access in rural areas. Large-scale compost production using water hyacinth is considered impractical due to the labor-intensive transportation process [7].

A SWOT analysis was carried out to identify internal (strengths and weaknesses) and external factors (opportunities and threats) which may influence the establishment of a market for water hyacinth products in Egypt (table. 1).

Water hyacinth can be managed in an environmentally friendly way to promote water sustainability in Egypt. The plant can be utilized in various industries, and a SWOT analysis of the market for water hyacinth products shows that there are both opportunities and challenges. With proper management and investment, water hyacinth can be a valuable resource for Egypt's economy and environment.

Table.1: SWOT analysis for the establishment of market for water hyacinth products in Egypt

STRENGTHS	WEAKNESSES
• Abundance of water hyacinth in Egypt's water bodies • Eco-friendly and sustainable alternative to traditional materials. • Potential to create new job opportunities and boost the local economy. • Growing interest in eco-conscious products among consumers • Availability of skilled labor and artisans for product manufacturing	• Limited awareness and understanding of water hyacinth products among consumers • Lack of established market channels and distribution networks • Challenges in scaling up production to meet market demands • Potential for inconsistency in product quality and standardization. • Limited financial resources for initial investment and marketing efforts.
OPPORTUNITIES	**THREATS**
• Collaborations with local government authorities for waste management initiatives • Export opportunities to international markets interested in sustainable products • Potential partnerships with existing eco-friendly brands and retailers • Growing demand for eco-tourism and nature-inspired products in Egypt • Increasing consumer consciousness towards sustainable living	• Competition from other sustainable material options in the market • Potential negative perceptions or skepticism towards water hyacinth products • Fluctuating raw material prices and availability • Possible regulatory and legal challenges in harvesting and processing water hyacinth. • Economic volatility and market uncertainties. • Environmental challenges, such as changes in weather patterns or outbreaks of diseases that might affect water hyacinth growth and availability.

SWOT Analysi

Acknowledgment

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Impact of EL-Qatafi Dam on Wadi Ghamr and Hazeem Runoff by Applying SCS Curve Number Method

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Keywords: Antecedent Soil Moisture Condition (AMC), Curve Number (CN), Hydrologic Soil Groups (HSG), Water Index, Water body volume.
CWW2023 Theme: 5

ABSTRACT

Desert dam named El-Qatafi has been constructed; by the mid of 2022 at a narrow outlet at almost 8 Km EN of wadi Ghamr and Hazeem, based on the Bedouin request. Hence after the first wet season 2022 - 2023 they were complaining of disappearing runoff in the wadi. This paper aims to evaluate the impact of EL-Qatafi dam on Wadi Ghamr and Hazeem to preserve a sustainable ecological system downstream the dam. Geographic information system (GIS), and Remote Sensing (RS) techniques were used to estimate and validate surface runoff during 2022- 2023 through SCS-CN model, water index and water body volume.

SCS-CN method was developed by US Department of Agriculture to calculate runoff depth in which CN is estimated using a combination of land use, soil, and Antecedent Soil Moisture Condition (AMC). Songara et al., (2015) [1] showed that estimation of runoff by SCS-CN method integrated with GIS can be used in watershed management effectively.

Since there is no gauging in the NSB to measure runoff discharge, an approach of two steps were applied to validate SCS-CN model. First delineating water surface area for each storm event by remote sensing data. Landsat has recently been used to undertake long term monitoring of surface water bodies at global (Pekel et al., 2016) [2] and regional scales (Mueller et al., 2016). Water indices' techniques such as Normalized Difference Water Index (NDWI) (McFeeters, 1996) [3] and Modified Normalized Difference Water Index (MNDWI) (Xu, 2006) [4], were used in this research for the delineating water surface area. Second, estimating the volume of water body. Several criteria had been used to calculate the water volumes of water bodies at specific times based on the availability of morphometric and areal data. Lane and D'Amico (2010) [5] calculated the water volume of isolated wetlands in North Central Florida, USA, utilizing lidar data and the triangulated irregular network (TIN) polygon volume model in ArcGIS.

Based on a 45 years historical daily rainfall record, majority of storms that occurred had less than 11 mm of rainfall, strong storms with 38 mm of rainfall occurred twice in the last 45 years. The extremal condition was represented by having 50 mm event which happened once. Four isohyetal maps for each of the storm event during the winter of 2022-2023 were

produced. The driest storm was in December with an average of 6.5 mm while the rainiest storm was in last days of May with an average of 27 mm. The other two storm had the most frequent event with 15 mm.

The SCS-CN method relies on several factors, including rainfall (P), Land Use/Land Cover patterns (LULC), Antecedent Moisture Condition (AMC), and Potential Maximum Retention (S). The analysis of the LULC data revealed that approximately 99% of the land cover consisted of bare lands, such as basaltic rocks, sands, chert plains, dry mud, and bare soil. Regarding the hydrological soil groups (HSG), approximately 89.3% of the composition was made up of Group C and D soils.

Under the average moisture condition curve number for each pixel ranged between 77- 94. Since storm events during 2022-2023 occurred under dry moisture conditions, with minimal rainfall, the calculated curve numbers for these dry conditions were modified to be range between 58 – 87 see figure (1). More than 87% of the watershed had a curve number above 80, which indicates high runoff. The potential maximum retention (S) values varied between 38 and 180 mm, while the initial abstraction (Ia) ranged from 3.9 to 18 mm across the entire watershed.

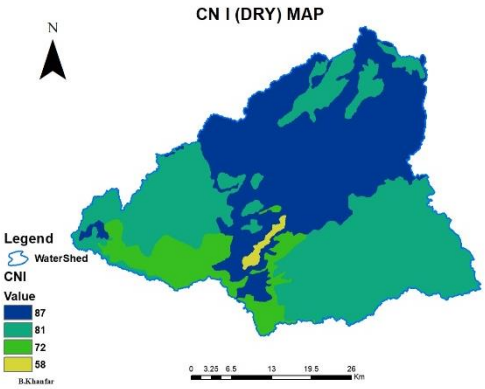

Figure 1. Curve number under the dry moisture condition

Runoff estimates were higher for the storm with a longer return period, while lower runoff estimates were obtained for storms with shorter return periods (11 mm or less). The overall runoff for the winter season 2022-2023 was computed based on four storms, summation of runoff volume over the qatafi catchment is found to be 2.4, 0.12, 2.7, and 11.4 MCM, respectively with maximum runoff depth of 10 mm and minimum runoff depth of 0.1 mm (Table 1).

Table 1. Runoff depth during year 2022 – 2023 over the Qatafi watershed

Date	Runoff Depth Q (mm)			
	CNI=86.8	CNI=80.9	CNI=70.41	CNI=58.43
11/15/2022	0 - 3.54	0 - 3.48	0 - 1.43	0 - 1.3
12/24/2022	0 - 0.24	0 - 0.16	0 - 0.23	0 - 0.16
3/15/2023	0 - 2.76	0.16 - 2.74	0.14 - 2.3	0 - 2.2
28-29/5/2023	0.3 - 10	1.43 - 9.78	1.4 - 8.1	0.2 - 7.8

To validate the model, two storms event (Storm date: 15-11-2022, 28-05-2023) were used, as there were no water body delineated by water index MNDWI (1) giving better accuracy check. Five water body developed after the 15/11/2022 and 11 after 28/5/2023.

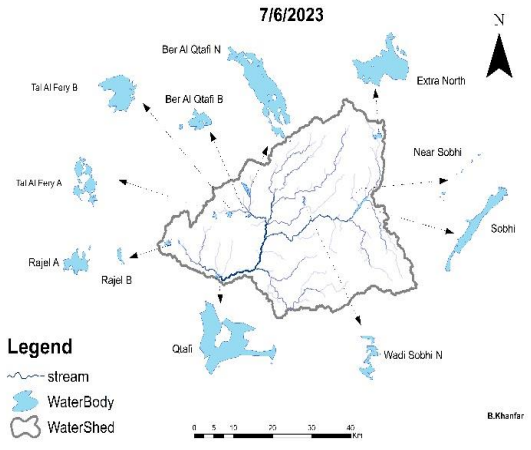

Figure 2. Water bodies after storm event 28/5/2023

Comparing the total water volume of the Qatafi watershed from the remote sensing image with estimated volume by SCS-CN model. Results showed 2.431 MCM to 2.428 MCM respectively with 0.1%

absolute percent error for storm 15/11/2022 which classified as an average short return period event. As for the 28/05/2023 event; recognized as long term period storm, it showed 11.121 to 11.430 MCM respectively with 2.8% percent error.

Conclusion

The construction of the Qatafi desert dam aimed to gather rainwater for the purpose of irrigating crops, providing water for livestock, and injecting groundwater. Nevertheless, the research findings revealed that the Qatafi Dam has detrimental effects on the downstream ecosystem due to its inhibition of surface runoff into Wadi Ghamr and Hazeem, becide not enhancing the natural recharge process.

The study discovered that although the dam was initially designed for a watershed area covering 1750 square kilometers, the actual area from which it collects water is only 1504 square kilometers. Additionally, its design was predicated on a rainfall rate of 50 millimeters during storms. However, this 50-millimeter measurement was identified as an exceptional event that occurs approximately once every 45 years. Regarding the recharge ratio, the research indicated that even though the geological formation of the outcrop has aquifer characteristics, it is overlaid silty clay loam soil with low permeability that keep water on the surface for evaporation.

Recommendation

Several Proposed Actions are suggested to manage water resource in NSB starts with improving used data by establish a network of monitoring stations to track rainfall and transpiration rates across the basin, deployment of valley recorders (gauging station) at various points within the basin to analyze seasonal runoff patterns, gather soil samples covering the entire basin area to assess soil permeability. Incorporating of a groundwater injection system into aquifers to enhance water harvesting efficiency due to low natural recharge, filtration, and high evaporation rates.

References

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