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ESTIMATE WATER REQUIREMENTS OF WHEAT USING CROPWAT-8 SOFTWARE – ASWAN GOVERNORATE – EGYPT.

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ABSTRACT: This research aims to study soil's physical, chemical, and hydro-physical properties, and then integrate them with climatic characteristics to determine the water consumption needed for wheat crops using CROPWAT-8 of FAO 2008. Daily climatic data from 2006 to 2013 of Abo simple station were used to calculate the ETo, ETc, and water consumption of wheat crops. The findings revealed that temperature, humidity, wind speed, and solar radiation all influence seasonal variations in ET. The results of calculating the water requirements for the wheat crop (Egypt 1) in the study area depended on the sowing date, as it gave the lowest water needs when planting in the first week of November 2022 (4230.0 m^3/feddan/season). There was a gradual increase in water requirements as it changed. The highest water needs were reached 6086.51 m^3/feddan/season when wheat planting in the first week of January 2023.

Keywords: Soil physical and chemical properties, CROPWAT-8, wheat, planting date.

INTRODUCTION

Harris *et al.* (2013) concluded that the irrigation water required for wheat crops to obtain the highest productivity is not a constant value during growth. In successive seasons, water requirements may decrease, ranging from 360 to 440 mm, while in dry and warmer seasons, water requirements increase, ranging from 480 to 550 mm, to obtain the maximum productivity of wheat crops. Rahimi *et al.* (2014) concluded that using CROPWAT-8 software applications to calculate the amount of evaporation, evapotranspiration, and water requirements of the wheat crop was the most valuable method. Laaboudi *et al.* (2015) concluded that the water requirements of wheat crops are related to climatic characteristics. They illustrated that the water requirements are very high in arid areas, medium in semi-arid areas, and low in semi-humid areas. Therefore, irrigation is necessary during the entire wheat crop cycle in arid areas with a low amount of rainfall. Krishna *et al.* (2017) illustrated that the water requirements of wheat crops using CROPWAT-8 applications ranged from 237.9 to 266.9 mm during the seasons 2014-2015 and 2015-2016, respectively. They concluded that the water requirements at the late stage of growth recorded the highest water requirements for the crop (130.7 and 136.7 mm/stage), which amounted to 45.0 and 48.7% of the total water requirements of wheat crops during the seasons 2014-2015 and 2015-2016. Taha *et al.* (2017), announced that the most suitable date for planting wheat in the northern Nile Delta is between November 15-30, and when adequate amounts of rainwater are available in the winter with irrigation water in the northern Nile Delta, it represents an effective reduction for scheduling irrigation of the wheat crop. They proved that the presence of rainwater contributed to rationalization rates of reduced irrigation water ranging between 27.3 and 46.6% of the total water requirements for the wheat crop. Ewaid *et al.* (2019), concluded that the use of FAO CROPWAT-8 software applications showed that crop water requirements and schedules were spatially linked to the study area due to the seasonal climatic and environmental characteristics of the area. Mahmoud and Yossif (2020) concluded that the actual water requirement is 2532.68 m3/acre/season in the

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study area, which is less than the value calculated using FAO program applications (2791 m3/acre/season). Also, the actual crop evapotranspiration coefficient (Kc) estimated from remote sensing (RS) using NDVI and SAVI applications with the AGDD equation is useful for irrigation scheduling. Tewabe *et al.* (2021), showed that using 75% of the simulated irrigation water depth in CROPWAT-8 applications for four different water depths starting from 9.3 mm in the initial stage, 22.9 mm in the development stage, 44.1 mm in the intermediate stage, and 25.8 mm in the late stage, respectively, gave wheat productivity of 3.37 t/ha and water productivity of 1.01 kg m-3. They concluded that the CROPWAT model is an important tool for calculating the water requirements of field crops in irrigated agriculture. Shaloo *et al.* (2021) used the Penman-Monteith method in MATLAB software and illustrated that wheat's water requirement (ETc) was increasing significantly for eleven districts. They concluded that this work could contribute to water management applications to the benefit from the irrigation water unit. Berca *et al.* (2021), explained that the wheat crop consumption of water is high and reached 1000 cubic meters of irrigation water/ton of grain in the study area. Therefore, they recommend that it is better to control the amount of water needed through irrigation scheduling, with the selection of wheat varieties with low water-specific consumption and high tolerance to water stress, which will have a positive impact on farmers. Kaini *et al.* (2022), showed that the changes in water requirements in the future will be minimal due to water shortages and the devastating effects of climate change. This will lead to a decrease in crop productivity and affect farmers' activities as well. They indicated that the level of education in the new reclamation areas may be necessary to improve the assistance of young graduates and farmers in improving their knowledge and facing the challenges towards irrigation schedule and using best land management practices.

This research aims to study the physical, chemical, and hydro-physical soil properties and then integrate them with climatic characteristics to determine the water consumption needed for wheat plants using the CROPWAT-8 application.

Location of the studied area

The study area is located in the New Valley Governorate in the southern part north of the Aswan-Toshka desert road and is suited between latitudes 22° 53´ 03.06' N and 23° 6´ 46.32' N and between longitudes 31° 29´ 47.66' E and 31° 35´ 35.83' E. The Universal Metric Projection System (UTM WGS1984 Zone 36) was used as the coordinate system for the all-GIS layers of the study area.

MATERIALS AND METHODS

Materials used

Sentinel-2 images with a 10-meter resolution (Date in July 2022) were used. Two topographic sheets of the study area scale of 1:25000 were used **(**GDMS, 2009). Spatial Dynamic Global Position System Software (DGPS) was used to define and determine the locations of the soil samples in the field. Double infiltrating tube with open ends. And an Aluminum tube to measure some physical and hydrology soil properties. Plastic bags, lapels, and descriptive sheets for collected soil samples.

Software

Arc GIS 10.8 software (ESRI, 2021). The CROPWAT - 8.0 is produced by the Food and Agriculture Organization (FAO, 2008).

Techniques and Methods

Field studies

Six soil sites were selected based on different soil types in the study area. sites P1, P2, P3, P4, P5 and P6 were in wheat field. Dynamic global positioning devices were used to locate the sites**.** Table (1) shows the coordinates of the selected soil points. The IR (infiltration rate) measurements in the field (Tricker, 1978) were recorded and then collected the soil samples to measure some physical and chemical properties. Saturated Hydraulic conductivity (HC), Bulk density (BD), and moisture retention curves (MRC) were measured using undisturbed soil following the methods of, Burt, 2004; Klute, 1986 and Stolte, and Veerman 1997 respectively.

Table (1): The coordinates of the selected soil points.

Point No.	Long	Lat
P. 1	31° 33' 31.476" E	23° 06' 30.129" N
P. 2	31° 32' 24.347" E	23° 01' 25.888" N
P. 3	31° 33' 41.805" E	23° 01' 31.725" N
P. 4	31° 31' 36.027" E	22° 58' 01.146" N
P1 5	31° 31' 50.544" E	22° 59' 02.270" N
P. 6	31° 32' 23.965" E	22° 53' 19.744" N

Laboratory work

The fractions below 2 mm were subjected to chemical and physical analyses after air-drying, gently crushed, and then sieved soil samples. The soil paste extraction, EC, pH, SAR, particle size distribution, calcium carbonate content, and gypsum content (Burt, 2004). The undisturbed core samples were used to calculate Bulk Density (BD), Total porosity (P), and HC according to Klute (1986).

Climatological data

The climatological data of Abu Simbel agriculture station, for the period from 2006 to 2022, were used to calculate ETo of the study area in mm/day using CROPWAT-8. Table (2) shows the climatological data of Abu Simbel agriculture station in Aswan Governorate.

Calculate reference evapotranspiration (ETo):

Using the decision support software CROPWAT 8.0 which is developed by FAO, the ETo was calculated, based on Allen *et al.* (1998).

Table (2): Climatology data of Abu Simbel agriculture station, Aswan Governorate

Month	Temperature (°C)		Humidity %	Rain	wind speed	Sun Hours
	Maximum	Minimum	Mean	mm	(m/s)	
January	23.4	10.3	39.0	0.0	3.2	10.9
February	26.4	12.7	31.3	0.0	3.5	11.2
March	30.5	15.9	23.4	0.0	3.8	11.9
April	34.4	20.5	22.0	0.0	3.8	12.5
May	37.7	24.5	17.4	0.35	3.7	13.2
June	41.5	26.8	18.0	0.0	3.5	13.6
July	41.6	27.6	19.6	0.14	3.3	13.3
August	41.7	27.8	20.4	0.0	3.4	11.4
September	39.0	26.0	23.8	0.0	3.6	12.2
October	36.6	22.7	28.3	0.0	3.0	11.5
November	30.6	17.7	34.4	0.0	3.3	10.8
December	25.2	12.0	39.1	0.0	3.3	11.6
Average	34.1	20.4	26.4	0.49	3.5	12.0

Average of daily climatic data from 2006 to 2022, Elevation: 192 meters above Sea level, Latitude.: 22.36° N, Longitude: 31.61° E

Calculate irrigation water requirement (IWR)

The crop evapotranspiration (ETc) was calculated by multiplying the reference crop evapotranspiration (ETo), by the crop coefficient (Kc). The Kc values of the crops used in this study were obtained from FAO No. 56 according to the results of actual experiments in Egypt (Allen *et al.* 1998). Finally, the irrigation water requirement was calculated using Irrigation efficiency.

RESULTS AND DISCUSSION

Chemical and physical properties of soil

The cross-section (CS: Average of 75 cm) of soil properties from physical and chemical analyses is presented in Table 3. The results indicate that the predominant soil texture was classified as sandy clay loam, followed by sandy loam and clay classes. The results indicated that soil salinity levels varied from slight salaries to moderate saline, with certain locations exhibiting high salinity as depth increased. The percentage of calcium carbonate levels varies from slight to moderate, except for points 2 and 3, which exhibit higher values as depth increases.

The physical soil properties of the studied (BD, HC, P) are shown in Table (4). BD values ranged from low (1.35 g/cm^3 to 1.41 g/cm^3), medium (1.41 g/cm^3 to 1.47 g/cm^3) and finally high (1.49 g/cm3 to 1.59 g/cm^3) in some parts of the study area, while the P values ranged from 3.2 to 51.9% with an average of 42.88%. Finally, the HC results indicate that there are differences within each area studied. The low values ranged from 1.1 cm/hour to 1.9 cm/hour, while the medium values in certain areas ranged from 2.0 cm/hour to 2.7 cm/hour. Additionally, the texture category (clay) resulted in a high rate of 3.1 to 4.1 cm/hour in sectors P2, P3, P5, and P6, where they were particularly high.

Table (3): Chemical and physical analyses of the soil samples.

Profile No	SP % CS	pH CS	EC. dS/m CS	SAR CS	Sand % CS	Silt % CS	Clay% CS	Texture CS	$CaCO_3$ % CS	Gypsum % CS
P1	54.63	7.44	29.25	10.80	40.58	16.50	42.92	Clay	12.69	0.77
P2	32.06	7.83	18.92	21.61	60.96	18.25	20.79	Sandy Clay Loam	30.05	0.87
P3	31.75	7.65	22.79	11.93	51.79	18.92	29.29	Sandy Clay Loam	15.65	0.84
P4	34.00	7.83	7.77	10.15	54.55	21.63	23.82	Sandy Clay Loam	9.15	0.56
P5	26.00	7.93	11.32	28.71	67.77	22.12	10.11	Sandy Loam	3.32	0.81
P6	34.33	7.84	13.80	8.86	55.96	18.37	25.67	Sandy Clay Loam	7.77	0.92

Table (4): Physical analysis of the selected profiles

Profile No	Bulk density CS.	Total porosity CS.	Hydraulic conductivity CS.
P1	1.37	50.41	1.65
P2	1.44	50.60	3.39
P3	1.45	49.68	2.03
P4	1.39	50.76	2.66
P5	1.51	3.62	3.12
P6	1.39	50.17	1.81

Infiltration rate (IR) and soil moisture retention curve

To calculate the time required for soil saturation reach, it is critical to understand the IR of the soil and estimate the factors that influence it. Knowing the basic IR is particularly important when designing a pivot or sprinkler irrigation system. The rate of water sprayed via pivot or sprinklers should not exceed the basic IR to avoid loss due to surface water runoff.

Table (5) shows the field capacity (FC), available water (AW), welting point (WP), and IR of the selected points. The results indicated that the IR of point No. P4 was very low, and IR, point No P3, and P6 were low. IR points No. P1 was moderate and IR points No. P2 and P5 were the highest IR in the study area. These findings reflected the soil texture of the surface and subsurface layers, which decreased in the subsurface layer due to an increase in fine soil particles at depth. The results of the FC values illustrated that it was high in P1, and P5 compared with the profile P6 which was low FC values, while it was moderate in P3 due to the increased clay content. The results of the WP values showed that it is related to the FC values in the study area, as changes in texture and some soil characteristics cause a change in the FC values.

Table (5): Field capacity, wilting point, available water, and infiltration rate of the selected points.

Profile No	pF						FC%	WP%	AW%	IR cm/hr.
	0	0.1	0.33	0.66	1	15				
P1	44.45	42.01	38.05	36.73	34.62	19.60	42.01	19.60	22.41	5.4
P2	32.42	29.85	27.51	23.87	19.79	10.68	29.85	10.68	19.16	7.1
P3	35.13	32.76	30.59	27.70	22.45	12.48	32.76	12.48	20.28	3.5
P4	30.27	27.77	24.93	22.50	18.77	9.99	27.77	9.99	17.78	2.4
P5	28.45	25.33	24.57	22.24	18.69	9.89	25.33	9.89	15.44	6.2
P6	28.68	26.60	24.02	20.75	16.01	9.21	26.60	9.21	17.38	3.7

FC%: field capacity, WP%: welting point, AW%: available water

Crop water consumption

Table 6 shows the monthly ETo (reference evapotranspiration) data calculated with the Penman-Monteith method in the CROPWAT-8 software (FAO 2008). The principal findings from the table are as follows: Minimum temperatures vary from 10.3°C in January to 27.8°C in August, whereas maximum temperatures range from 23.4°C in January to 41.7°C. Relative humidity peaks in January and December at 39%, while it reaches its minimum in May at 17%. Wind speed varies from 2.2 m/s in January to 3.8 m/s in March and April. The maximum sunshine duration occurs in May, averaging 13.2 hours, whereas the minimum is recorded in August at 11.4 hours. Radiation levels reach a maximum in June at 30.4 MJ/m²/day and decline to a minimum in January and December at 19.4 MJ/m²/day. ETo reaches its peak in June at 11.02 mm/day and its minimum in January at 3.99 mm/day. The annual average ETo is 8.19 mm/day. Seasonal variations in ET are influenced by temperature, humidity, wind speed, and solar radiation.

Table (6): Monthly ETo data, as determined by the CROPWAT-8 program and Penman-Monteith (FAO 2008).

Month	Minimum Temperature	Maximum Temperature	Humidity	Wind speed	Sun	Radiation	ETo
	°C	°C	%	m/s	hours	MJ/m²/day	mm/day
January	10.3	23.4	39	2.2	10.9	19.4	3.99
February	12.7	26.4	31	3.5	11.2	22.0	6.01
March	15.9	30.5	23	3.8	11.9	25.6	7.91
April	20.5	34.4	22	3.8	12.5	28.3	9.31
May	24.5	37.7	17	3.6	13.2	29.8	10.33
June	26.8	41.5	18	3.5	13.6	30.4	11.02
July	27.6	41.6	20	3.2	13.3	29.8	10.54
August	27.8	41.7	20	3.3	11.4	26.6	10.30
September	26.0	39.0	24	3.6	12.2	26.5	9.87
October	22.7	36.6	28	3.0	11.5	23.1	7.84
November	17.7	30.6	34	3.2	10.8	19.7	6.26
December	12.0	25.2	39	3.2	11.6	19.4	4.94
Average	20.4	34.0	26	3.3	12.0	25.0	8.19

Wheat crop (Masr 1) characteristics

Characteristics of wheat crops (Masr 1) with different planting dates were applied using CROPWAT-8. Table (7) shows the characteristics of the wheat crop (Masr 1) in the southern part of El Wadi El Gadid. Five proposed planting dates of wheat crop (Masr 1) were proposed every 15 days starting from 01/11/2022, 15/11/2022, 1/12/2022, 15/12/2022, and the last date 01/01/2023. The maximum crop height during the stage is 1.00 m. This data offers important insights into the development of wheat crops and their water requirements at various stages, along with performance variations based on planting dates.

Table (7): Wheat crop characteristics with different Planting date.

Crop data with different Planting date (Wheat: Masr 1)					
(File:\Program Data\CROPWAT\data\crops\FAO\Wheat south valley. CRO)					
Crop Name: Wheat Masr 1	Planting date: 01/11/2022			Harvest: 30/03/2022	
	Planting date: 15/11/2022			Harvest: 13/04/2022	
	Planting date: 01/12/2022			Harvest: 29/04/2022	
	Planting date: 15/12/2022			Harvest: 13/05/2022	
	Planting date: 01/01/2023			Harvest: 30/05/2022	
Stages	Initial	Development	Mid	Late	Total
Length (days)	15	40	65	30	150
Kc Values	0.40		1.15	0.25	
Rooting depth (m)	0.30		1.20	1.20	
Critical depletion	0.55		0.55	0.90	
Yield response f.	0.70	0.90	1.15	0.40	1.00
Crop height (m)			1.00		

Land characteristics

Table (8) summarizes the characteristics of six different soil types (P1–P6) in the southern part of El Wadi El Gadid, calculated using CROPWAT-8. The key findings include total available water (mm/m) varies between 170 mm/m (P2, P6) and 300 mm/m (P5). P5 has the greatest capacity for water retention. Maximum soil IR (mm/day) varies greatly, with P2 having the highest rate (71 mm/day) and P4 having the lowest (24 mm/day). All soil types have a consistent maximum rooting depth of 120 cm. All soils have an initial depletion level of 70%. Initial AW ranges from 51 mm/m (P2, P6) to 90 mm/m (P5), indicating that P5 has the most AW to begin with, while P2 and P6 have the least. This data demonstrates the variability in water retention and infiltration capacity among the six soil types, which is important for managing irrigation and water resources.

Table (8): the six soil types of characteristics in the southern part of El Wadi El Gadid

General soil data	P1	P2	P3	P4	P5	P6
Total available water in mm/m	240	170	200	180	300	170
Maximum soil infiltration rate mm/day	54	71	35	24	62	37
Maximum rooting depth cm	120	120	120	120	120	120
Initial soil moisture depletion %	70	70	70	70	70	70
Initial available soil moisture mm/m	72	51	60	54.0	90.0	51.0

Crop water requirements

The water requirements of wheat crops for each growth stage were calculated using the CROPWAT-8 program. The crop evapotranspiration for each decade was calculated by multiplying the number of effective crop days. Gross irrigation represents the depth of water (expressed in mm) applied to the field. Since irrigation efficiency is usually less than 100%, only a small portion of the gross irrigation depth, i.e. net irrigation depth, reaches the root zone of the crop. In the table unit, flow represents the continuous water discharge required to meet the crop irrigation requirements throughout the irrigation period. It is expressed in liters per second per hectare which was calculated and then converted to cubic meters per decade per acre.

Table (9) shows the irrigation requirements starting from the planting date, November 1, 2022. The irrigation requirement per decade (10 days) varies according to crop growth stage and climatic conditions. For example, in the mid-stage (January to February), the irrigation requirement is approximately 263.66 to 397.14 m³/dec/fed (m³ per 10-day period per feddan). The highest water demand is in February, with approximately 397.14 m³/dec/fed.

Total water requirement: The crop cycle requires 4230 m³/fed of irrigation water, with February being the peak month. This data provides critical insights for effectively managing water resources throughout the wheat growing season, ensuring that the crop receives enough water at all stages.

Table (10) shows the irrigation requirements for the planting date, November 15, 2022. February and early March have the highest water demand, requiring 400-527 m³/dec/fed (m³ per 10-day period per feddan) for irrigation. In April, the irrigation requirement gradually decreases to approximately 145.98 m³/dec/fed by the end of the season. Total irrigation water requirements for the crop cycle are 4681.36 m³/fed, higher than the 01 November planting date (4230.00 m³/fed) due to longer growth and increased water needs later in the season. This data optimizes water use for different planting dates, ensuring efficient wheat irrigation.

A comparable discourse was deemed appropriate for tables 11, 12, and 13. Table 11 presents the irrigation requirements for the planting date of December 1, 2022. Table 12 presents the irrigation requirements for the planting date of December 15, 2022. Table 13 presents the irrigation requirements for the planting date of January 1, 2023. In this context, investigations into soil texture and structure, soil water characteristic curves, and the application of CROPWAT software to examine the impact of climate change on planting dates were conducted by Zhao *et al.* (2013), Omran *et al.* (2023), and Abdelazez *et al.* (2024).

Table (9): Irrigation requirements for the planting date of November 1, 2022.

Month	Decade	Stage	ETo	Kc	ETc	75% Irr. Req	Irr. Req	Irr. Req/Total Dec
			mm/day	Coeff	mm/dec	mm/dec	m^3/dec/fed	m^3/fed
November	1	Init	6.26	0.4	25.04	33.39	140.22	**140.22**
November	2	Deve	6.26	0.43	26.92	35.89	150.74	**856.26**
November	3	Deve	6.26	0.6	37.56	50.08	210.34	
December	1	Deve	4.94	0.8	39.52	52.69	221.31	
December	2	Deve	4.94	0.99	48.91	65.21	273.87	
December	3	Mid	4.94	1.16	57.30	76.41	320.90	**2303.30**
January	1	Mid	3.99	1.18	47.08	62.78	263.66	
January	2	Mid	3.99	1.18	47.08	62.78	263.66	
January	3	Mid	3.99	1.18	47.08	62.78	263.66	
February	1	Mid	6.01	1.18	70.92	94.56	397.14	
February	2	Mid	6.01	1.18	70.92	94.56	397.14	
February	3	Mid	6.01	1.18	70.92	94.56	397.14	
March	1	Late	7.91	1.01	79.89	106.52	447.39	**930.22**
March	2	Late	7.91	0.7	55.37	73.83	310.07	
March	3	Late	7.91	0.39	30.85	41.13	172.75	
Total Irrigation water Need								**4230.00**

Table (10): Irrigation requirements for the planting date of 15 November 2022.

Month	Decade	Stage	ETo	Kc	ETc	75% Irr. Req	Irr. Req	Irr. Req/Total Dec
			mm/day	Coeff	mm/dec	mm/dec	m3/dec/fed	m3/fed
November	2	Init	6.26	0.4	25.04	33.39	140.22	**140.22**
November	3	Deve	6.26	0.4	25.04	33.39	140.22	**746.07**
December	1	Deve	4.94	0.53	26.18	34.91	146.62	
December	2	Deve	4.94	0.73	36.06	48.08	201.95	
December	3	Deve	4.94	0.93	45.94	61.26	257.28	
January	1	Mid	3.99	1.13	45.09	60.12	252.49	**2512.92**
January	2	Mid	3.99	1.19	47.48	63.31	265.89	
January	3	Mid	3.99	1.19	47.48	63.31	265.89	
February	1	Mid	6.01	1.19	71.52	95.36	400.51	
February	2	Mid	6.01	1.19	71.52	95.36	400.51	
February	3	Mid	6.01	1.19	71.52	95.36	400.51	
March	1	Mid	7.91	1.19	94.13	125.51	527.12	
March	2	Late	7.91	1.19	94.13	125.51	527.12	**1282.15**
March	3	Late	7.91	0.81	64.07	85.43	358.80	
April	1	Late	9.31	0.48	44.69	59.58	250.25	
April	2	Late	9.31	0.28	26.07	34.76	145.98	
Total Irrigation Water Need								**4681.36**

Table (11): Irrigation requirements of Planting Date 01 December 2022.

Month	Decade	Stage	ETo	Kc	ETc	75% Irr. Req	Irr. Req	Irr. Req/Total Dec
			mm/day	Coeff	mm/dec	mm/dec	m3/dec/fed	m3/fed
December	1	Init	4.94	0.40	19.76	26.35	110.66	**110.66**
December	2	Deve	4.94	0.43	21.24	28.32	118.96	**706.07**
December	3	Deve	4.94	0.62	30.63	40.84	171.52	
January	1	Deve	3.99	0.83	33.12	44.16	185.46	
January	2	Deve	3.99	1.03	41.10	54.80	230.14	
January	3	Mid	3.99	1.19	47.48	63.31	265.89	**2540.61**
February	1	Mid	6.01	1.20	72.12	96.16	403.87	
February	2	Mid	6.01	1.20	72.12	96.16	403.87	
February	3	Mid	6.01	1.20	72.12	96.16	403.87	
March	1	Mid	7.91	1.20	94.92	126.56	531.55	
March	2	Mid	7.91	1.20	94.92	126.56	531.55	
March	3	Late	7.91	1.20	94.92	126.56	531.55	**1605.55**
April	1	Late	9.31	1.00	93.10	124.13	521.36	
April	2	Late	9.31	0.68	63.31	84.41	354.52	
April	3	Late	9.31	0.38	35.38	47.17	198.12	
Total Irrigation Water Need								**4962.89**

Table (12): Irrigation requirements of Planting Date 15 December 2022.

Month	Decade	Stage	ETo	Kc	ETc	75% Irr. Req	Irr. Req	Irr. Req/Total Dec
			mm/day	Coeff	mm/dec	mm/dec	m3/dec/fed	m3/fed
December	2	Init	4.94	0.40	19.76	26.35	110.66	**110.66**
December	3	Deve	4.94	0.41	20.25	27.01	113.42	**618.40**
January	1	Deve	3.99	0.55	21.95	29.26	122.89	
January	2	Deve	3.99	0.75	29.93	39.90	167.58	
January	3	Deve	3.99	0.96	38.30	51.07	214.50	
February	1	Mid	6.01	1.16	69.72	92.95	390.41	**3443.68**
February	2	Mid	6.01	1.21	72.72	96.96	407.24	
February	3	Mid	6.01	1.21	72.72	96.96	407.24	
March	1	Mid	7.91	1.21	95.71	127.61	535.98	
March	2	Mid	7.91	1.21	95.71	127.61	535.98	
March	3	Mid	7.91	1.21	95.71	127.61	535.98	
April	1	Mid	9.31	1.21	112.65	150.20	630.85	
April	2	Late	9.31	1.21	112.65	150.20	630.85	**1498.58**
April	3	Late	9.31	0.81	75.41	100.55	422.30	
May	1	Late	10.33	0.49	50.62	67.49	283.46	
May	2	Late	10.33	0.28	28.92	38.57	161.97	
Total Irrigation Water Need								**5671.30**

Table (13): The irrigation requirements of Planting Date 01 January 2023.

Month	Decade	Stage	ETo	Kc	ETc	75% Irr. Req	Irr. Req	Irr. Req/Total Dec
			mm/day	Coeff	mm/dec	mm/dec	m3/dec/fed	m3/fed
January	1	Init	3.99	0.4	15.96	21.28	89.38	**89.38**
January	2	Deve	3.99	0.4	17.16	22.88	96.08	**863.98**
January	3	Deve	3.99	0.6	24.74	32.98	138.53	
February	1	Deve	6.01	0.8	49.88	66.51	279.34	
February	2	Deve	6.01	1	62.50	83.34	350.02	
February	3	Mid	6.01	1.2	71.52	95.36	400.51	**3900.99**
March	1	Mid	7.91	1.2	95.71	127.61	535.98	
March	2	Mid	7.91	1.2	95.71	127.61	535.98	
March	3	Mid	7.91	1.2	95.71	127.61	535.98	
April	1	Mid	9.31	1.2	112.65	150.20	630.85	
April	2	Mid	9.31	1.2	112.65	150.20	630.85	
April	3	Mid	9.31	1.2	112.65	150.20	630.85	
May	1	Late	10.3	1	106.40	141.87	595.83	**1232.16**
May	2	Late	10.3	0.7	73.34	97.79	410.72	
May	3	Late	10.3	0.4	40.29	53.72	225.61	
Total Irrigation Water Need								**6086.51**

Conclusion

In specific locations, the FC values exceed those of soils with lower FC values. In most soil profiles, however, it exhibits a greater increase with depth. Changes in soil properties and texture influence FC values, establishing a relationship between wilting point values and FC values in the study area. Profile number P1 exhibited the highest AW value due to its clay percentage. The results of the study area regarding the estimation of water requirements for the wheat crop (Egypt 1) were influenced by the sowing date. Planting during the first week of November 2022 yielded the lowest water requirement at 4230.0 m^3/feddan, with a gradual increase observed as the sowing date was adjusted. Planting dates should occur in the first week of January 2023, or until the peak water requirements (6086.51 m^3/feddan) are attained.

REFERENCES

Abdelazez, E.; Shalaby, H.; Aly, S. and Omran, W. (2024). Impact Of Climate Change On Wheat Water Consumption In Some Egyptian Regions. Menoufia Journal of Soil Science, 9 (4): 49-68. Doi: 10.21608/Mjss.2024.282363.1025

Allen, R. G.; Pereira, L. S.; Raes, D. and Smith, M. (1998). Crop evapotranspiration: Guide-lines for computing crop water requirements, In FAO Irrigation and Drainage Paper No. 56; FAO: Rome, Italy., 300p.

Berca, M., Robescu, V.-O., & Horoias, R. (2021). Winter wheat crop water consumption and its effect on yields in southern Romania, in the very dry 2019–2020 agricultural year. Notulae Botanicae Horti Agrobotanici Cluj-Napoca, 49(2), 12309. DOI:10.15835/nbha49212309

Burt, R. Ed. (2004). Soil Survey Laboratory Methods Manual, Soil Survey Investigations Report No. 42, Version 4.0, USDA-NRCS, Lincoln, Nebraska.

ESRI (2021). Arc Map version 10.8 User Manual. ESRI, 380 New York Street, Redlands, California, USA.

Ewaid, S. H.; Abed, S. A. and Al-Ansari, N. (2019). Crop Water Requirements and Irrigation Schedules for Some Major Crops in Southern Iraq, Water., 11, 756; doi:10.3390/w11040756. https://www.mdpi.com/journal/water.

FAO (2008). CROPWAT 8.0 has been developed by Joss Swennenhuis for the Water Resources Development and Management Service of FAO, Water Resources Development and Management Service, Land and Water Development Division, Food and Agriculture Organization of the UN, Viale delle Terme di Caracalla, 00153 Rome, Italy, website at: http : // www .fao. org /nr/ water/ infores-databases-cropwat.html.

GDMS (2009). Topographic map produces by General Directorate of Military Survey, scale 1:25000.

Harris, G.; Payero, J.; Jackson, R. and Peake, A. (2013). WATERpak – a guide for irrigation management in cotton and grain farming systems", Cotton Research & Development Corporation, Final report, Australian Government, PP: 290-297.

Kaini, S.; Harrison, M. T.; Gardner, T.; Nepal, S. and Sharma, A. K. (2022). The Impacts of Climate Change on the Irrigation Water Demand, Grain Yield, and Biomass Yield of Wheat Crop in Nepal, Water 2022, 14, 2728. https://doi.org/10.3390/w14172728.https://www.mdpi.com/journal/water.

Klute, A. Ed (1986). Methods of Soil Analysis. Part 1. Physical and Mineralogical Methods, Soil Science Society of America, Book Series No 5, 2nd Edition, Madison, Wisconsin, USA.

Krishna, D.; Mishra, S. R.; Singh, A. K.; Mishra, A. N. and Singh, A. (2017). Water requirement of wheat crop for optimum production using CROPWAT model Journal of Medicinal Plants Studies.; 5(3): 338-342.

Laaboudi, A.; Allaoua, C.; Hafouda, L.; Ballague, D.; Sbargoud, S.; Meterfi, J. and Herda, F. (2015). Crop coefficient and water requirement for wheat (Triticum aestivum) in different climate regimes of Algeria, International Journal of Agricultural Policy and Research, 3 (8): 328-336, August.

Mahmoud, A. K. and Yossif, T. M. H. (2020). Estimating of Wheat Water Requirement Using Remote Sensing at El-Menia Governorate Desert Fringe-Egypt, J. of Soil Sciences and Agricultural Engineering, Mansoura Univ., 11 (12): 727 - 732.

Omran, W.; Abd El-Mageed, T.; Sweed, A. and Awad, A. (2022). A modified equation for fitting the shape feature of the entire soil water characteristic curves. Egyptian Journal of Soil Science, 63(1): 15–34. https://doi.org/10.21608/ejss.2022.164765.1541

Rahimi, D.; Khademi, S. and Nad, S. (2014). Estimation of Evaporation and Transpiration of Wheat Plant in Zaraghan Station Using CROPWAT Model, International journal of Advanced Biological and Biomedical Research, 2 (4): 1362-1370.

Shaloo., Bisht, H.; Sarangi, A.; Prajapati, V. K.; Mishra, A. K. and Singh, M. (2021).Water Requirement and its Trend for Rice and

Wheat Crops in Haryana State, India, International Journal of Current Microbiology and Applied Sciences., 10 (02): 203-209.

Stolte, J. and Veerman, G. J. (1997). Determination of the water retention characteristic using the pressure plate extractor. Manual for soil physical measurements. Version 3. Wageningen, DLO-Staring Centre. Technisch Document/ Technical Document 37: 77.

Taha, A. A.; Ibrahim, M. A.; Mosa, A. M. and EL-Komy, M. N. (2017). Water Productivity of Wheat Crop as Affected by Different Sowing Dates and Deficit Irrigation Treatments, J. Soil Sci. and Agric. Eng., Mansoura Univ., 8 (10): 521 - 529.

Tewabe, D.; Abebe, A.; Tsige, A.; Enyew, A. and Worku, M. (2021). Determination of crop water requirements and irrigation scheduling of wheat using CROPWAT at Koga and Rib irrigation scheme, Ethiopia, Research Square, DOI: https://doi.org/10.21203/rs.3.rs-717969/v1.

Tricker, A. S. (1978). The infiltration cylinder: Some comments on its use. Journal of Hydrology, 36: 383-391, Elsevier Scientific Publishing Company, Amsterdam.

Zhao, P.; Shao, M. A.; Omran, W. and She, D. (2013). A modified model for estimating the full description of soil particle size distribution. Canadian Journal of Soil Science, 93(1): 65-72.

تقدير الاحتياجات المائية للقمح باستخدام برنامج CROPWAT-8 - الجزء الجنوبي الغربي من محافظة أسوان - مصر.

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الملخص العربى

يهدف هذا البحث إلى دراسة الخصائص الفيزيائية والكيميائية لاراضى منطقة الدراسة، ثم دمجها مع الخصائص المناخية لتحديد استهلاك المياه اللازمة لمحصول القمح باستخدام برنامج CROPWAT-8 المنتج من منظمة الأغذية والزراعة ٢٠٠٨ وذلك لمواعيد زراعة مختلفة. تم استخدام البيانات المناخية اليومية من عام ٢٠٠٦ إلى عام ٢٠١٣ لمحطة أبو سمبل لحساب ETo و ETc ، واستهلاك المياه لمحصول القمح.كشفت النتائج أن درجة الحرارة والرطوبة وسرعة الرياح والإشعاع الشمسي تؤثر جميعها على الاختلافات أظهرت النتائج النهائية لحساب الاحتياجات المائية لمحصول القمح (مصر ١) في منطقة الدراسة يتوقف على موعد الزراعة حيث أعطت أقل الاحتياجات المائية عند الزراعة في الأسبوع الأول من شهر نوفمبر ٢٠٢٢ (٤٢٣٠ م^{٣}/فدان/موسم) ثم حدثت زيادة تدريجية في كمية الاحتياجات المائية مع تغير ميعاد الزراعة وصلت أعلى الاحتياجات المائية ٦٠٨٦,٥١ م^{٣}/فدان/موسم عند زراعة القمح في الأسبوع الأول من شهر يناير ٢٠٢٣.

الكلمات المفتاحية: خواص التربة الفيزيائية والكيميائية – برنامج كروب وات ٨ – القمح – تاريخ الزراعة.