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Factors Affecting on the Weather and Oceanography Parameters in Different Structural Areas of Red Sea, Egypt

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Abstract:

The coastal semi closed areas located along Red Sea are critical regions, The areas under study spread in the western Red Sea on the Egyptian coastal included four areas located between 26° 37' 00'' and 23° 09' 05'' N, these consecutively from northerly to southerly; Safaga Bay, Hamrawien, Sharm El Bahri and Shallatien. It is found that differ structural and human intervention may contribute to climatic and environmental changes of the hydrological semiclosed coastal areas. The incident solar radiation suffers from decay due to a combination of weather factors, but in some areas is increased about default values as a result of reflection from the surrounded mountains. Also the metrological parameters values are differed about its default value as air temperature in Safaga, relative humidity in Sharm El Bahri. The penetration solar radiation is suffering in the Hamrawien from the phosphate dust whereas the surface water temperature is the highest in Sharm El Bahr and the surface water salinity is the highest in Safaga. The water density in Shallatien is affected by the desalination plant outlet.

Keywords: Red Sea, Solar Radiation, Temperature, Density, Salinity, Relative Humidity

1.0 Introduction:

Sun radiation, light from the sun is important for the ocean system in the globe for different reasons; because it furnishes the vitality required for ocean currents and wind-driven waves (Meza and Varas, 2000). Some of that energy is converted into heat helps to form a thin layer of warm water near the surface of ocean that support most marine life. More importantly, the transfer of light in sea water is essential to the productivity of the oceans. It has an important role in the photosynthesis process for the production of food. Therefore, the translate light in the sea; ocean is the main role for the ecology of the oceans.

Average net daily solar radiation, which transmitted into the sea surface ocean approximately 5% to 20% less than the incident radiation, this amount depends on the latitude, day of the year, wind speed, and sky conditions (Mobley and Boss, 2012). The transmitted light in the seas is affected by many factors such as solid particles and turbid water near the seashore (Frouin and Iacobellis, 2002), which is caused by the movement of water as the tide & current and biological production by microorganisms. In shallow water, the sun's rays have the ability to reach the bottom of the ocean, where it absorbs parts of this light, reflected back in the water column above it, or re-emitted as fluorescence. Depending on the water and optical properties of benthic depth, and light intensity may drop faster than expected, remain constant throughout the water column, or even with the increase in depth. (Maritorena *et al*. 1994). Solar radiation is one of the main factors that drive the ocean circulation, through the creation of horizontal density gradients and water mass formation. The absorbing of the solar radiation in the surface layer of the ocean depends on the pigments and particle concentration of the seawater (Jerlov, 1968; Morel and Antoine, 1994; Frouin and Iacobellis, 2002). The incident radiation and solar reflected radiation in Safaga were collected through daylong. The highest seasonal value of the incident solar radiation (1682.7 w/m^2) recorded during the summer, while a weak value (1074.0 w/m^2) was in winter. The seasonal intensity of reflected radiation was fluctuating between 255.1 & 32.3 w/m^2 at surface and 300.3 & 39.6 w/m^2 near bottom, respectively (saman, 2006).

Wyrtki, (1961) was pointed that the thermohaline processes is caused changing in the surface temperature and salinity of the ocean surface layer, consequently the density. It is found that the areas of sloping topography play an important role in controlling both the circulation and the properties of the water masses formed by buoyancy-forcing. Where the transport heat into the basin and the water density is exported to the open ocean, Spall, (2005). The water parcel moves to stay under less dense water and above more dense water. Stewart, (2008) pointed to the following the water movement, needing to know the water density distribution. Where the distribution of water current depends on the distribution of pressure, subsequently the variations of density.

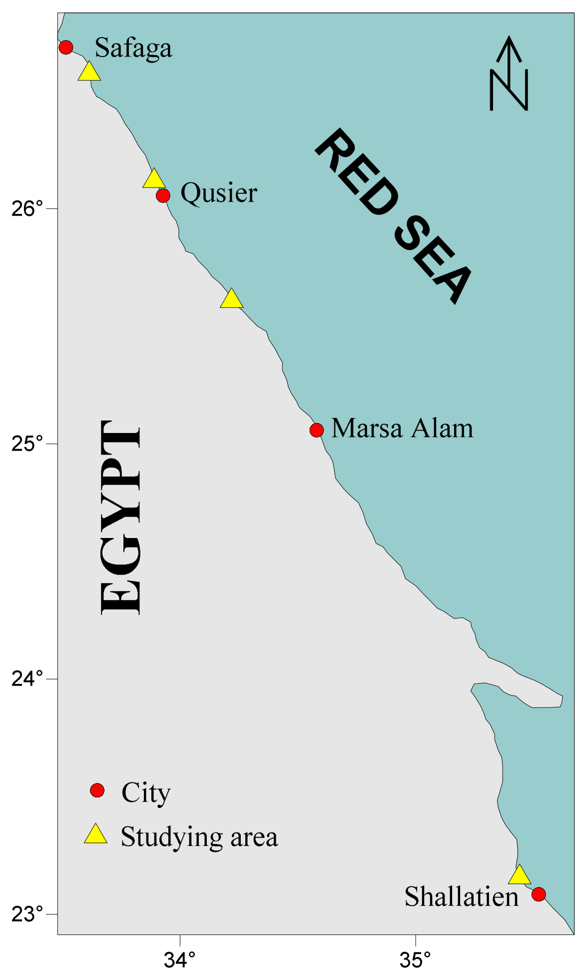

Fig. (1): Map of the areas location under study.

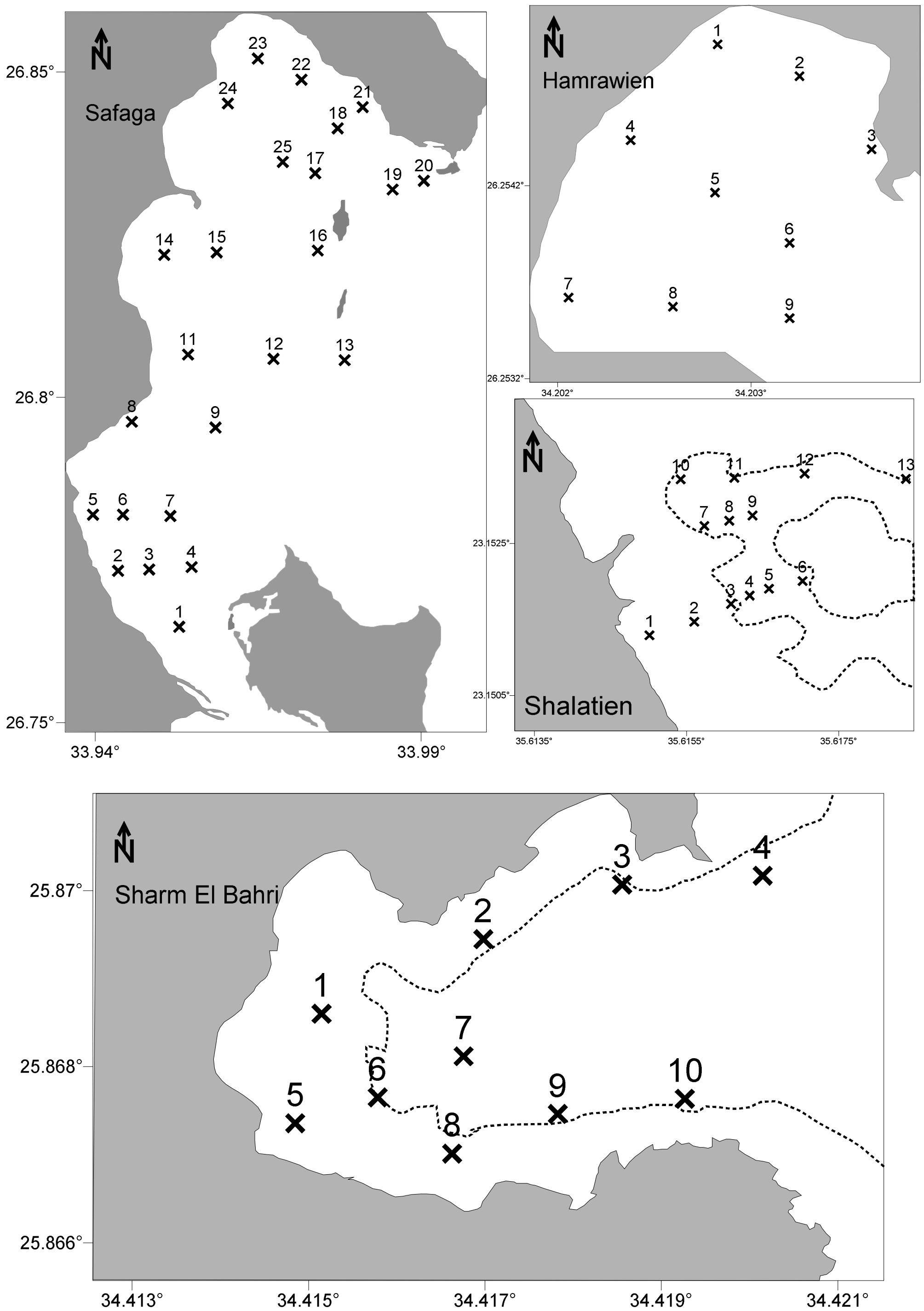

Fig. (2): Maps of the construction area and stations distributed.

The water temperature and salinity are the main factors can effect on the density of sea water. The water density increases with decreasing temperature and increasing salinity, but salinity has a lower effect on the density of water than Temperature (Talley *et al.,* 2002). This study tries to answer about the question that: Is the differences in different structure and human activities in coastal areas could lead to changes in atmospheric Physical factors and physical oceanography factors? Also to determine On the other hand, identify the factors that affect the water temperature, salinity, water intensity of solar radiation in four different areas of the structure.

1.1 The study Area:

The areas under study spread in the western Red Sea on the Egyptian coastal included four areas these consecutively from northerly to southerly; Safaga Bay, El Hamrawien, Sharm El Bahri and Shallatien,

A) Northern Safaga Bay, Safaga bay is situated on the West Coast of the Red Sea. Safaga Island divided this bay into northern and southern Safaga bay, constructing a narrow Channel. The northern Safaga bay confined to latitudes 26° 37' & 26° 52'N and longitudes 33° 56'& 34° 00', (fig I). The northern border is the prominent peninsula of Ras Abu Soma, while the southern is bordered by Safaga Island, with a wide, shallow water area, (down to 5m-water depth). In the center of NSB two islands are situated, oriented N- S direction fig (2).

B) Hamrawein Harbour It is located at about 20 km north of Quseir City, lies between latitudes $26^{o}\ 15^{\backslash}\ 02^{\backslash\backslash}$N & $26^{o}\ 15^{\backslash}\ 17^{\backslash\backslash}$N and longitudes $34^{o}\ 12^{\backslash}\ 07^{\backslash\backslash}$E & $34^{o}\ 12^{\backslash}\ 00^{\backslash\backslash}$E (Fig.1). This harbor lies at the mouth of Wadi El-Hamrawein. The tidal flat is very narrow and extents smoothly with gently slope seaward (Fig. 2).

C) Sharm El-Bahari represents protected mangrove swamp, located at 103 km north Marsa Alam and 33 km south Quseir between latitude $25^{o}\ 52^{\backslash}\ 07^{\backslash\backslash}$ N and longitude $34^{o}\ 24^{\backslash}\ 49^{\backslash\backslash}$ E (Fig. 1). The mangrove swamp is healthy and the density increases at the entrance of sharm and also at the northern side. The sharm is surrounded with raised beach from both north and south wards (Fig. 2).

D) Shalatien site represents semi closed area. It is located at 700 km south Hurghada lies between latitude $23^{o}\ 09^{\backslash}\ 05^{\backslash\backslash}$ N and longitude $35^{o}\ 36^{\backslash}\ 51^{\backslash\backslash}$ E (Fig. 1). This area is shallow crowded with the ships and boats, also the suction pumps room of main Shalatein desalination plant was created on the metal jetty situated in the middle of the harbor in addition to, the reject pipeline is fixed at the middle beach (Fig. 2).

2.0 Data and Methods Analysis:

The environmental data as surface water temperature and salinity were recorded from 57 stations distributed as (Safaga, 25 stations, Hamrawien, 9 stations, Sharm El Bahri 10 stations and from Shalatien 13stations) by multiparameter (Hana instrument). Water temperature and salinity were calibrated against protected thermometer and induction salinometer (RS10). The depths recorded by lowerance X25 instrument (calibrated by vertical wire measurements). While the positions were recorded by two Global position system GPS (Magellan, 1000, 5000pro). LI-189 (Quantum/ Radiometer/ photometer), is recorded the intensity of incident solar radiation in the air and the penetration radiation at 5m under sea surface level from proceeding stations.

The water density (ρ) values were calculated from the equation, (Unesco, 1987):

$$\rho\,(s,t,0) = \rho_w + (b_0 + b_1 t + b_2 t^2 + b_3 t^3 + b_4 t^4)s + (c_0 + c_1 t + c_2 t^2)s^{3/2} + d_0 s^2$$

$$\rho_w = a_0 + a_1 t + a_2 t^2 + a_3 t^3 + a_4 t^4 + a_5 t^5$$

Where a_0, a_1, a_2, a_3, a_4, a_5, b_0, b_1, b_2, b_3, b_4, c_0, c_1, c_2 and d_0 are constants, ρ_w (t,0,0) density of pure water at in situ temperature (t). Density is presented in the form of sigma –t (σ_t) where (σ_t) = (ρ-1) x 1000. The distribution maps were draw by using the Golden software surfere.

3.0 Results and Discussion:

The hinterland to all the Red Sea coasts consists of vast areas of desert or semi-desert, the influence of which is seen as a marked degree of continentally in the temperature regime along the coasts. Edward (1987) makes a comparison between air temperature in Hurghada, Jaddah and Massawa. Where the air temperature is fluctuating between 15.5 & 30.0 ºC in Hurghada, 23.5 & 32.0 ºC in Jaddah and 25.0 & 35.0 ºC in Massawa. Therefore, the air temperature increases in southerly direction all over the basin of Red Sea (Tarek *et al*. 2010; Bruckner *et al.* 2012, Al-Barakati *et al.* 2002 and Al-Subhi and Al-Aqsum 2008). Nevertheless, there are some coastal areas located along the Red Sea affected by the nearly Red Sea Mountain as Safaga city. These mountains reflected the solar radiation to Safaga city, then the air temperature rises up. This was clearly in figure (3) that showing raises air temperature in Safaga, about the southern location (El Hamraween). With the exception of the above, the air temperature increases southerly due to increasing the solar radiations southerly. The mangrove swamps spread in Sharm El Bahri abundantly, consequently, increases the relative humidity in the air (Kaunang and Medellu 2013). So Sharm El Bahri recorded the maximum value of relative humidity as shown in fig (3). Generally the relative humidity was increased from north to south agreed with Fouda and Gerges, 1994. The relative humidity considers effected factor on the solar radiation (Kounouhéwa *et al.,* 2012), it is ranged between 31.7% (Safaga) and 67.0% (Sharm El Bahri) (Limhoon and Bualert, 2013).

Solar radiation is the electromagnetic radiation affecting on the physical and biological cycles in the Earth. Also, it is causing the climate change on the Earth system (Osorio *et al*., 2013, Bal *et al.,* 2011). The incoming solar radiation is suffering when passes through the atmosphere by a combination of processes such as, scattering and absorption by cloud and aerosols. Where its absorb part of energy and emitting it again (Iqbal, 1983; Essery and Marks, 2007 and Kounouhéwa *et al.,* 2013**)**, in addition to, It depends on the location and times of the year (Álvarez *et al* 2011). Therefore the amount of solar radiation is extremely variable. The intensity of solar radiation increases from the northern location reached the maximum value in Shallatien except in the Safaga area that affected by the reflecting of radiation from the nearly surrounded mountain (Dubayah, 1994) (fig. 3). The average intensity of solar radiation was recorded 1116.5 w/m^2 in Safaga, 894.1 w/m^2 in Hamrawien, 955.5 w/m^2 in Sharm El Bahri and 1089.1 w/m^2 in Shallatien (table 1.).

The surface water temperature was the highest value in Sharm El Bahri (35.2^{o}C) due to the air temperature was higher about the other areas whilst it was lower values in Hamrawien (25.9 ^{o}C) affected by the decline the air temperature. Although the water temperature increases southward in the Red Sea (Morcos 1970, Edwards, 1987, Eltaib 2010), but this is different in coastal areas as shown in fig (4_a), where the water temperature were differ according to regional weather conditions.

The water salinity in the Red Sea increases northward with small variations (Eltaib 2010, Sofianos and Johns 2003). This is shown in varying the water salinity in the three southern studying areas (Fig. 4_b). Nevertheless the water salinity in Safaga Bay is the highest where this area isolated about the open sea by three Islands and it is shallow as shown in figure (3). The water density decreases southerly, also the regional condition play in these variations in Shallatien area. The average water density varies between 27.72 (in Safaga) and 25.54 (in Sharm El Bahri) during the studying period.

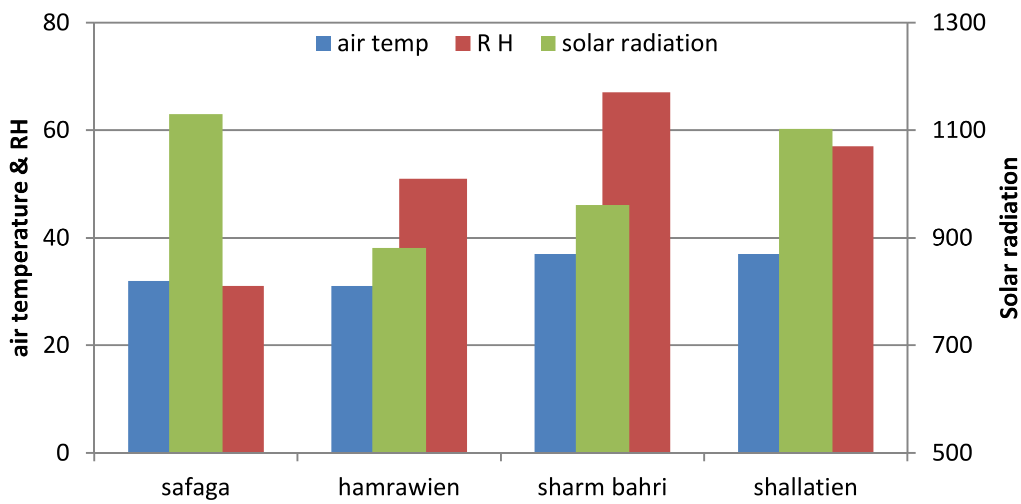

Fig. (3): The variation of air temperature, relative humidity and solar radiation in Safaga, Hamrawien, Sharm el Bahri and Shallatien.

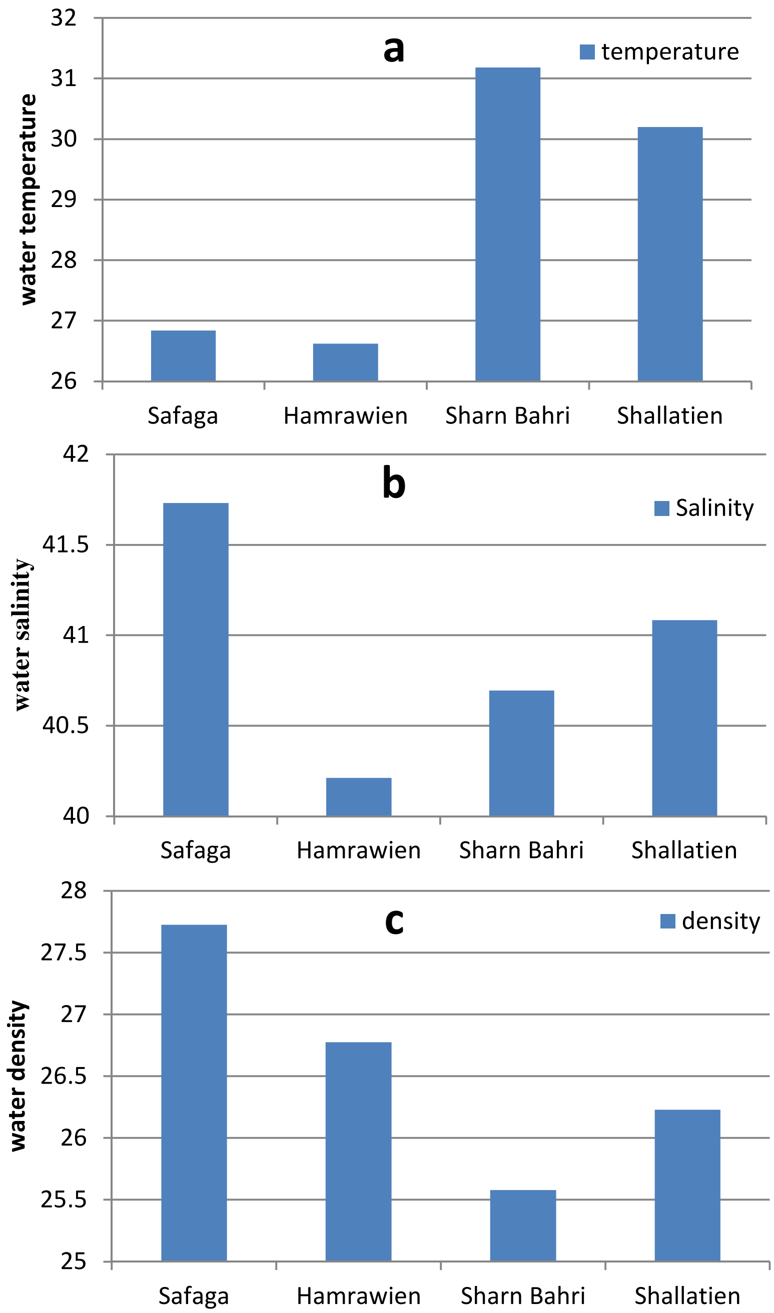

Fig. (4): The variations of a) water temperature, b) water salinity and c) water density in the Safaga, Hamrawien, Sharm El Bahri and Shallatien.

The horizontal distributions of the penetrating solar radiation during summer are shown in Fig. 5 in the four areas under study. On the whole, the intensity of solar radiation is higher in the shallowest part of Safaga bay and the highest value was in the northern protected area, while the density of solar radiation was lowest in near the coasts due to the turbulence. In El Hamrawien, during Phosphate loading operations, grains falling spread and distributed by size (Bingner and Theurer, 2003 ; Abed El-Wahab,2011). For that, the intensity of the penetration solar radiation extremely nearly the load performance, decreases landward due to dust settlement. For that the intensity was decreased steeply southward (the same wind direction). In Sharm El Bahri, the Mangrove trees cover some areas in the northern and western the Sharm, so the solar radiation cannot penetrate the tree, consequently the intensity is weak. Whereas the intensity was strong in two areas are characterized by water quiet and reflected the radiation from neighbor highland. Anyway, this area suffers from the strong current coming from the open sea. In Shallatien, the intensity of the solar radiation is stronger in the shallower and upper the coral reef areas. On the other hand, its notice that the intensity of the solar radiation in Safaga penetrated with lower value about the other areas this is due to Safaga exposed to the tow strong current (El saman, 2006) leads to turbulence in the sea surface of which scatter the solar radiation and may be the scattered radiation from the nearest mountain intersect with solar radiation lead to form destructive radiation. The intensity of the penetration solar radiation was varied between 12.25&78.38 w/m^2 in Safaga, 476 & 650 w/m^2 in Hamrawien, 68 & 835 w/m^2 in Sharm El Bahri and 101 & 870 w/m^2 in Shallatien. The previous results show that, every searched area is characterized with the capability of the penetrating solar radiation at the seawater surface, this is found in its different values and its distribution. Water density is considered an important factor, directly affects everything in the water due to the relationship between density of a fluid, weight of an object and buoyancy. The water density is affected by some factor as water temperature, water salinity, Pressure and Convergence & divergence, also evaporation, cooling of the surface water and the process of ice formation tends to increase the density of the ocean water. The conflicts in the density of ocean water are acting a main factor controlling on the oceanic circulation, besides it cause a vertical movement (upwelling). The density of sea water is rarely measured directly. But it calculated from measurements of salinity, temperature and pressure. The water density is a direct proportion with salinity and inversely with temperature. The horizontal distributions of the water density in Safaga and Sharm El Bahri are the same (figure 6) showed the distribution of water densities in the investigated areas. In Safaga, Due to the low water salinity and temperature in the open sea in comparison with the water in the investigated enclosed area, the water densities in the open sea is higher than it. Consquantly,the current water drive the dense water to the area decreases steeply entire the Safaga bay. This occurs in the Sharm el Bahri area however the northern Sharm el Bahri characterized by spread of Mangrove trees these increases the water salinity (Lovelock *et. Al.,* 2006), consequently density rises. The water density is highest off the southern coast in Shallatien may be affected by the desalination plant outlet. In Hamrawien, it affected by the rasies salinity in protected shallow water in the north and south El Hamrawien as show in fig (6_b) . Table (1) shows maximum water density (28.17) was in Safaga also the maximum water salinity (42.20) was in Safaga. Wheras the highest water temperature was 35.16^{o}C (in Sharm El Bahri)

Table (1): The Max., min. and average water temperature, salinity, density and the light intensity under and up sea surface water in the four areas under study

The Area		Water Temperature	Salinity	Density	Light under Water	Air Light
Safaga	Max.	28.02	42.20	28.17	78.4	1181.5
	Min	26.10	40.82	27.14	12.3	732.9
	Average	27.08	41.25	27.72	34.4	1116.7
Hamrawien	Max.	26.86	40.36	26.98	650.0	1116.0
	Min.	25.93	40.10	26.68	476.0	787.0
	Average	26.58	40.22	26.78	537.8	894.1
Sharm El Bahri	Max.	35.16	41.21	26.26	835.0	1057.0
	Min.	28.36	40.28	24.43	68.0	801.0
	Average	31.28	40.70	25.54	474.3	955.5
Shallatien	Max.	30.99	41.61	26.56	870.0	1196.0
	Min.	29.68	40.65	25.91	101.0	805.0
	Average	30.22	41.09	26.23	467.7	1089.1

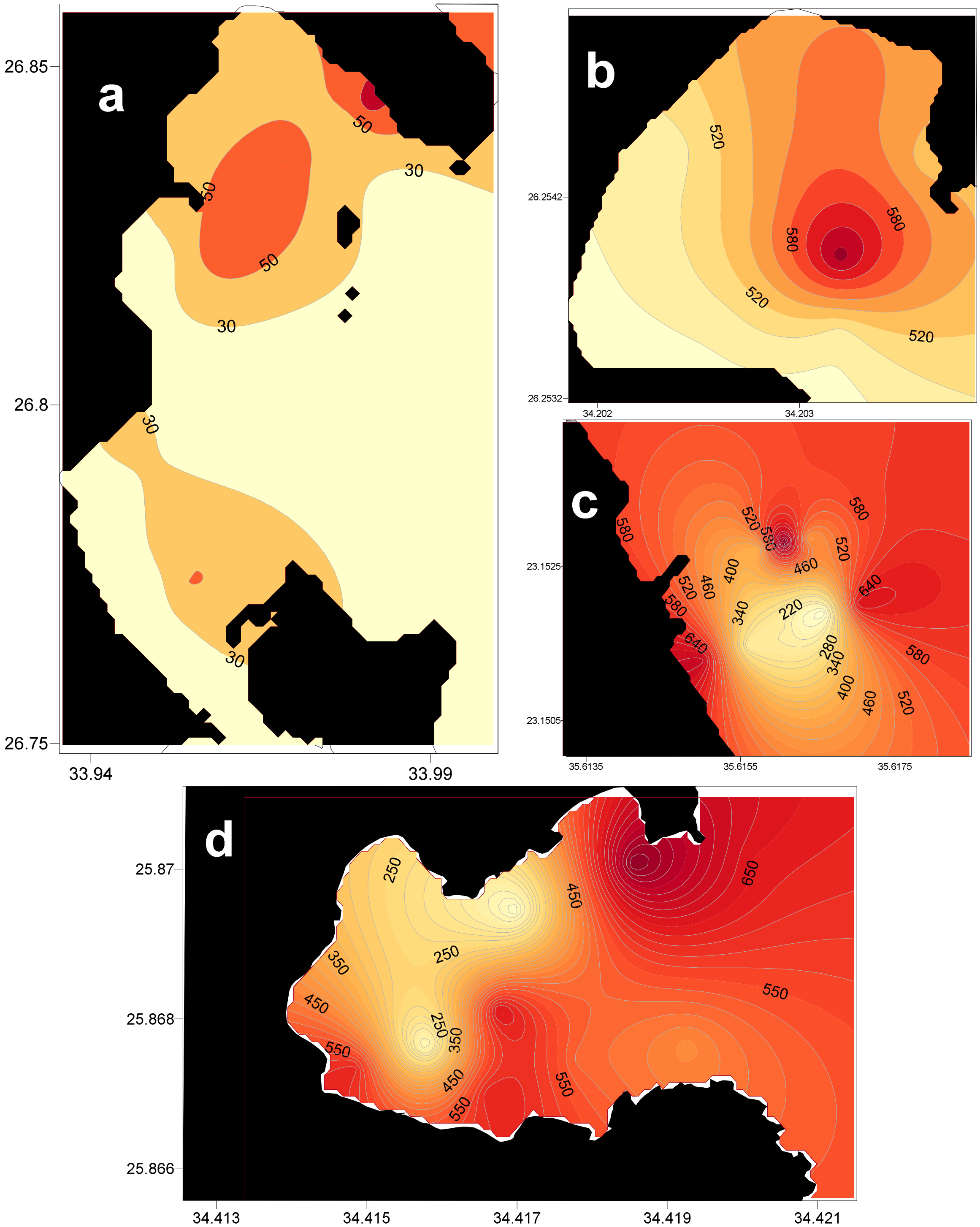

Fig. (5): Horizontal distribution of the penetrated solar radiation in a) Safaga , b) Hamrawien, c) Shallatien and d) Sharm El Bahri.

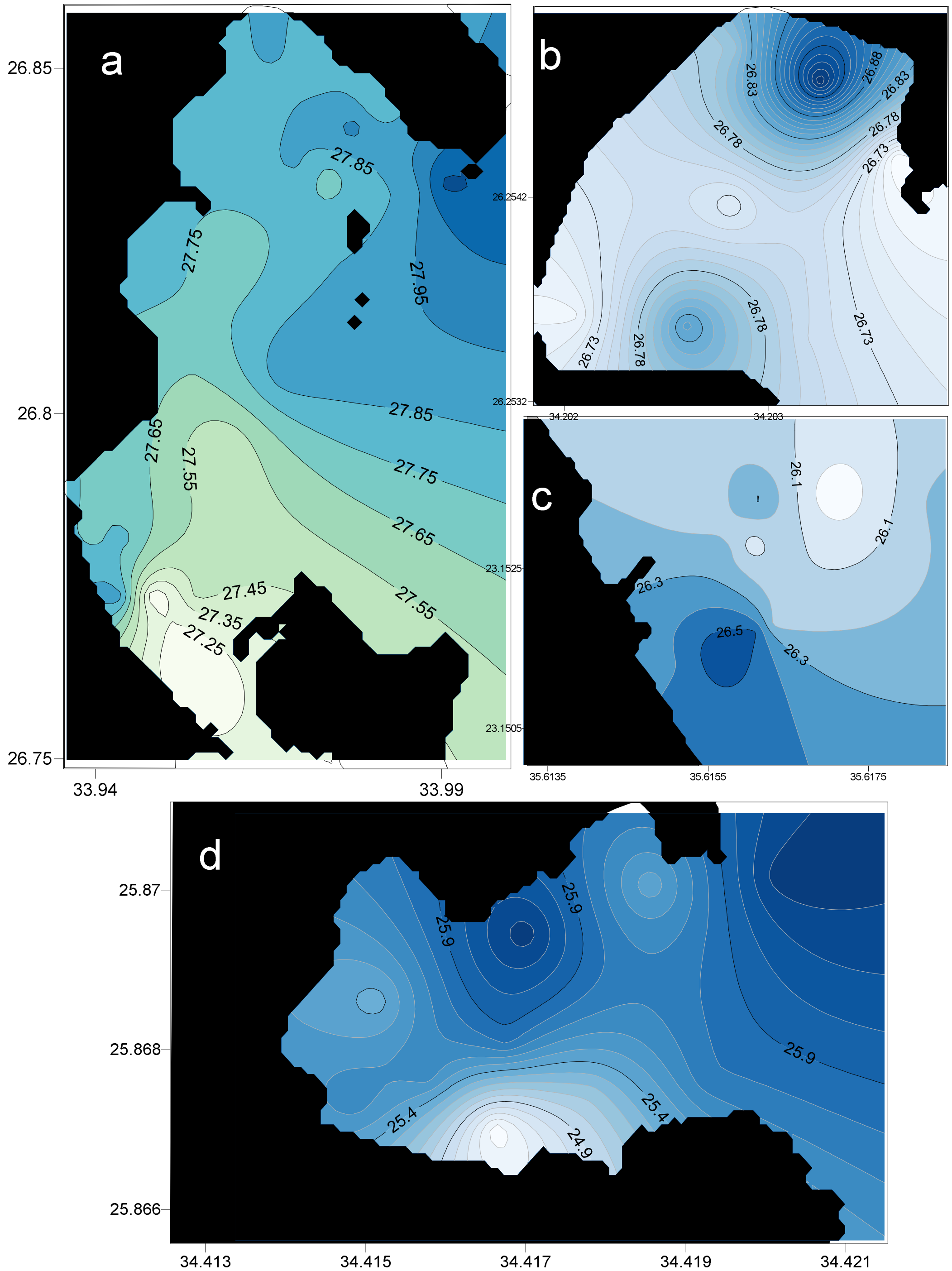

Fig. (6): Horizontal distribution of the penetrated water densities in a) Safaga, b) Hamrawien, c)Sharm El Bahri and d) Shalatien.

4.0 Conclusion:

The coastal semi closed areas located along Red Sea are a critical region, so the changes in the seawater properties from the place to other dependent on the some regional conditions. By study the sea water properties in the four areas, its find that the solar radiation in the air can be increasing in the area by reflecting from the surrounded mountains in Safaga. The air temperature is affected by the incident solar radiation, whereas the relative humidity is more affected by the mangrove swamp in Sharm El Bahri.

This simple transaction in the air factors as a result of differences in topographic for some areas and also as a result of human interventions (Hamrawien). Furthermore than previously, the physical parameters of sea water in these areas are affected. Whereas the penetration solar radiation is suffering in Hamrawien from the phosphate dust so it's lowest in the areas has the light dust. The surface water temperature is the highest in Sharm El Bahri affecting by rising of air temperature. The average intensity of solar radiation was recorded 1116.5 w/m^2 in Safaga, 894.1 w/m^2 in Hamrawien, 955.5 w/m^2 in Sharm El Bahri and 1089.1 w/m^2 in Shallatien. Whereas the intensity penetration solar radiation was varied between 12.25&78.38 w/m^2 in Safaga, 476 & 650 w/m^2 in Hamrawien, 68 & 835 w/m^2 in Sharm El Bahri and 101 & 870 w/m^2 in Shallatien. The maximum water density (28.17) was in Safaga also the maximum water salinity (42.20) was in Safaga. Wheras the highest water temperature was 35.16^{o}C (in Sharm El Bahri). Due to enclosed area and shallowness, Safaga recorded the highest value of water salinity. The water density in Shallatien is affected by the desalination plant outlet. Based on the previous results, the surrounded mountain in Safaga is affected on the solar radiation, air temperature and water temperature. Likewise, the mangrove in Sharm el Bahri affected on the water salinity and relative humidity. Human impact in Hamrawien leads to decreases in the solar radiation penetrated which decreases also by the water turbulence in some areas.

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