Eurasian Journal of Agricultural Research 2022; Vol: 6, Issue: 2, pp:110-119

The Assessment of Global Warming on Fish Production in Red Sea Region of Sudan

Wadah ELSHEIKH[1*], İlknur UÇAK[2], M. Cüneyt BAĞDATLI[3]

[1]*University of Khartoum, Faculty of Animal Production, Department of Meat Production, Khartoum, Sudan*
[2]*Nigde Omer Halisdemir University, Faculty of Agricultural Sciences and Technologies, Nigde, Türkiye*
[3]*Nigde Omer Halisdemir University, Facult of Architecture, Department of City and Regional Planning, Nigde, Türkiye*

[*]*Corresponding author: Wadah988@gmail.com*

ORCID:0000-0003-2506-2219[1], 0000-0002-9701-0824[2], 0000-0003-0276-4437[3]

Abstract

The Red Sea is one of the warmest and saltiest seas in the world. Generally Marine communities are facing increasing pressures especially with climate change. Climate change means changes in weather for years that either occur naturally or by human activities. Temperature, winds, vertical mixing, salinity, oxygen, pH and other physical and chemical elements, among others, have a range of direct and indirect effects that have an impact on fisheries. The direct effects act on the physiology, development rates, reproduction, behavior and survival of individuals and can in some cases be studied experimentally and in controlled conditions. Indirect effects act via ecosystem processes and changes in the production of food or abundance of competitors, predators and pathogens. Besides all that, Policymakers continue to pay insufficient attention to the fishing industry. Fisheries should be prioritized throughout the adaptation phase of policy development, and enough funding should be allocated to increase regional fish output that is sustainable. The aim of this study was to determine the effects of climate change on fish production in the Red Sea region of Sudan. It has been observed that the average maximum temperature for many years in the region is 33.8 ^{0}C. The total precipitation average was recorded as 165 mm. To reduce the potential effects of climate change on fisheries and food security for many impoverished fishing communities in Sudan, it is advised that expanded and sustained investments in market development, fisheries governance, and the provision of economic incentive mechanisms be made.

Keywords: Global Warming, Fish Production, Red Sea, Sudan

Research article
Received Date: 21 November 2022
Accepted Date: 29 December 2022

INTRODUCTION

Millions of people reside in communities that are reliant on the fruitful, nourishing abundance of fisheries around the shores of the world's seas and oceans, as well as along the shores of rivers and lakes. With this nutritional commodity, fish and other marine creatures play a clear role in supporting household food security in many nations.

The sale of seafood is a significant source of revenue for coastal towns (Matthews et al., 2014). More than 200 million Africans frequently consume fish, according to estimates (Heck et al., 2007).

Global climate change, the industrial revolution of the then mankind atmosphere to release the carbon dioxide, methane, ozone and nitrogen oxides as gases are very quickly heat the earth by the greenhouse effect that occurred as a result of the increase is a result of an increase above normal (Bağdatlı and Bellitürk, 2016a).

Increasing or decreasing changes in climatic values affect living things negatively and cause a decrease in productivity, especially in agricultural production (İstanbulluoğlu et al., 2013). The majority of African nations lack crucial data on the present situation and prospective contribution of fisheries resources to livelihoods and food security despite the fact that they are of utmost importance (Béné and Neiland, 2003). In many countries, family food security is clearly supported by aquatic products.

Increasing world population, changing climate conditions and economic activities are growing with each passing day makes it more important than water (Bağdatlı and Bellitürk, 2016b). There are changes in the water surface in the world due to global warming. This is the effect of evaporation in water resources and irregularity in the current precipitation regime due to climate change (Albut et al., 2018).

Sudan's freshwater fisheries are concentrated on the Nile River, its tributaries, and sizable reservoirs, As well as fisheries in the Red Sea. The Nile River System and the geography of Sudan are both ideal for aquaculture and catch fisheries. Sudan has an abundance of water resources. In Sudan, man-made lakes cover around 3,075 km^2. In 2017, Sudan's capture fisheries produced close to 38400 tons, 3300 tons from maritime captures and 35100 tons from catches in interior waters (FAO, 2019). Sudan has a total coastline of 853 km, and Its territorial rights in the Red Sea cover an Exclusive Economic Zone (EEZ) of 91 600 km^2 and a continental shelf area of 22 300 km^2. These waters are bountiful in fishing resources and also possess abundant coral populations. Although the coast is long, the marine fisheries sector in Sudan is small with official annual catches at 5000 tons in 2012 and 4000 tons in 2013 A catch reconstruction for 2010 of 2000 tons was low compared to the official catches statistics of 5700 tons, likely attributable to poor quality of available fisheries statistics in terms of degree of coverage and representatively (Tesfamichael and Elawad, 2016).

Sudan depends on fresh water fisheries where the Maximum Sustainable Yield (MSY) is about 110,000 tons. In comparison marine fisheries MSY stands at around 10,000 metric tons/annum (Ministry of Livestock and Fisheries, Sudan 2018**)**.

The world's per capita intake of fish is 34 kg per year, compared to Sudan's estimated 6.5 kg per year, which is deemed low when compared to other regional African nations (average: 13 kg per person/year), The fact that many tribes and tribal sub-sectors in red sea state dislike eating fish or shellfish of any kind or engaging in any type of fish-related activities (UNIDO, 2017).

Although utilization methods remain largely traditional, The Sudanese private sector and international businesses have lately made some limited efforts in the direction of commercial usage of fish deposits in the Red Sea.

Due to significant evaporation rates and a lack of riverine inputs, the Red Sea is one of the youngest seas on Earth, as well as one of the hottest and saltiest (Rasul et al., 2015). The Red Sea has a relatively short rejuvenation period, similar to other marginal seas, and is anticipated to react quickly to climate change given the current and impending environmental changes (Belkin, 2009).

Sea surface temperature (SST) in the Red Sea suddenly increased, according to Raitsos et al., (2011), with geographic patterns indicating greater increases in the north. According to Chaidez et al., 2017; there has been an increase of 0.25°C each decade, which is greater in its northern part.

Important issues about the Red Sea ecosystem's functioning and prospects in a changing environment are raised by the stated developments. Therefore, this study was carried out to assess the effects of Global Warming on Fish Production in red sea Region, Sudan. Stakeholders and decision-makers in Sudan would benefit from the findings of this study because they will enable them to more accurately estimate the effects of climate change and evaluate the viability of intervention alternatives.

MATERIAL AND METHOD

The study area includes the Nile River States and the Northern State (Figure 1), Red Sea is one of Sudan's 18 states. It has a 212,800 km^2 area and 1,482,053 people living there. The state's capital is Port Sudan. In this study, linear regression method was calculated for the analysis of climate data the standard deviation of the climatic data was also calculated. The Linear Regression Model is the most commonly used kind of regression in applications and is one of the oldest and most researched subjects in statistics. Regression analysis is a method for describing quantitative connections between one or more explanatory factors and a response variable (Rezaeianzadeh et al., 2014; Salihi and Üçler, 2021).

Figure 1. The location of research area

RESEARCH FINDINGS

Analysis of Climate Data

Figures 2, 3 and 4 shows the climatic change data including average Temperature (°C), Minimum temperature (°C), and Max. Temperature (°C). When we see on standard deviation average temperature, minimum temperature and maximum temperatures have almost same value of standard deviation. The highest max. temperature was 40.8 °C recorded in August, while the lowest min. temperature was 19.1 °C recorded in January.

While Figure 5 and 6 shows Precipitation and Rainy days, where it rains in all months of the year except May and June, while the highest rate of rain and the number of rainy days were in November and October. Figure 7 shows Humidity, the highest humidity recorded in October, November, December and January, while the lowest was in June and July. As for Figure 8, it shows the Sunny days, where the daylight hours were higher in June and July.

By performing a linear regression analysis between months and climatic change factors separately, the values of all climatic variables data may be explained. Where R^2 values indicate whether these climatic variables are closer to the regression line's expected values or not.

We find that the real values of all of these variables are not closer to the projected values after analyzing regression. Precipitation has higher R^2 value followed by Min. temperature, rainy days, Average temperature, humidity, Max temperature, and sunny days. Which means Precipitation actual values are closer to predicted values to some extent. It was found that real values of climatic variables are rapidly changing as a result of climate change.

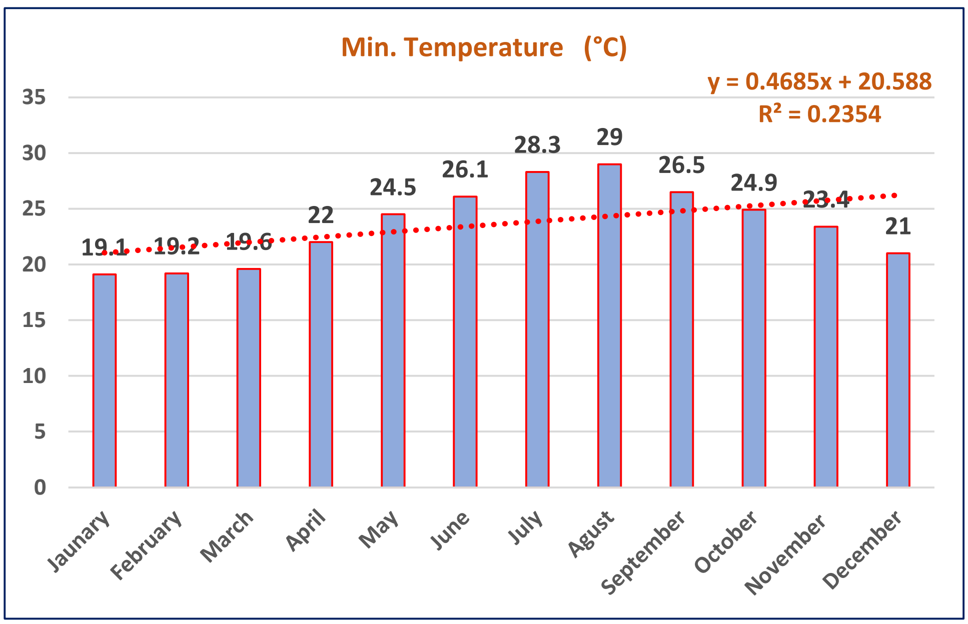

Figure 2. The distributions of Min. Temperature according to months

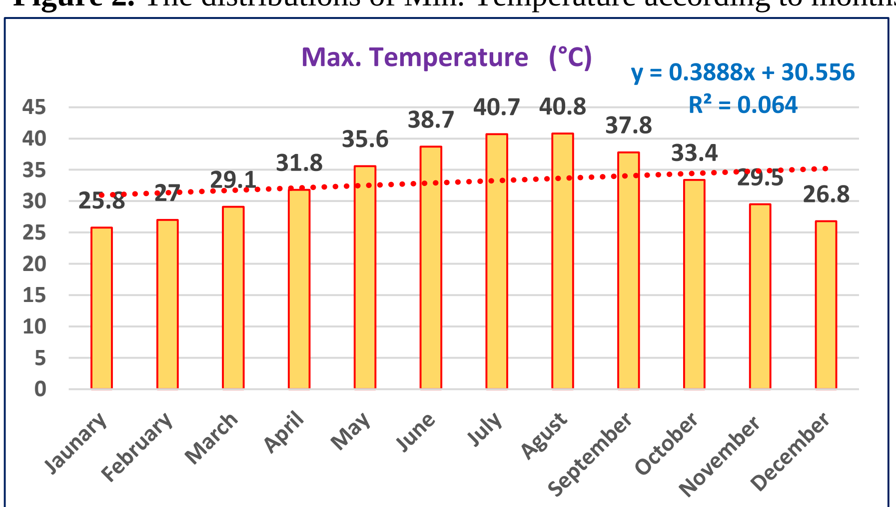

Figure 3. The distributions of Max. Temperature according to months

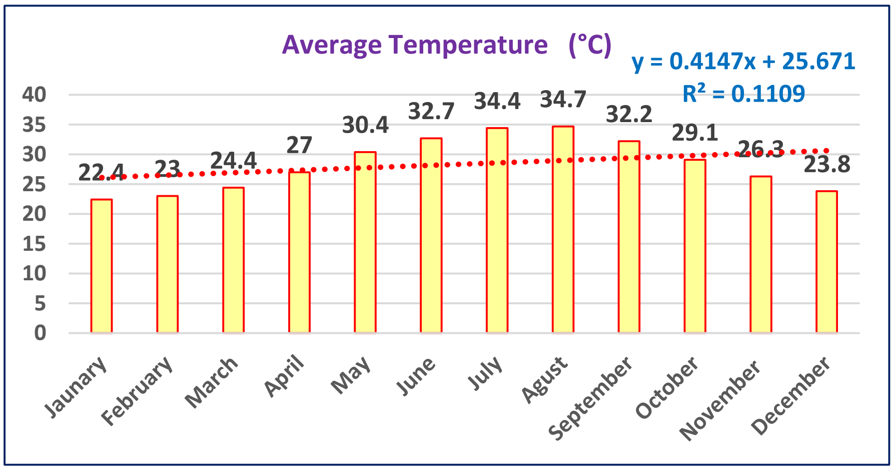

Figure 4. The distributions of Average Temperature according to months

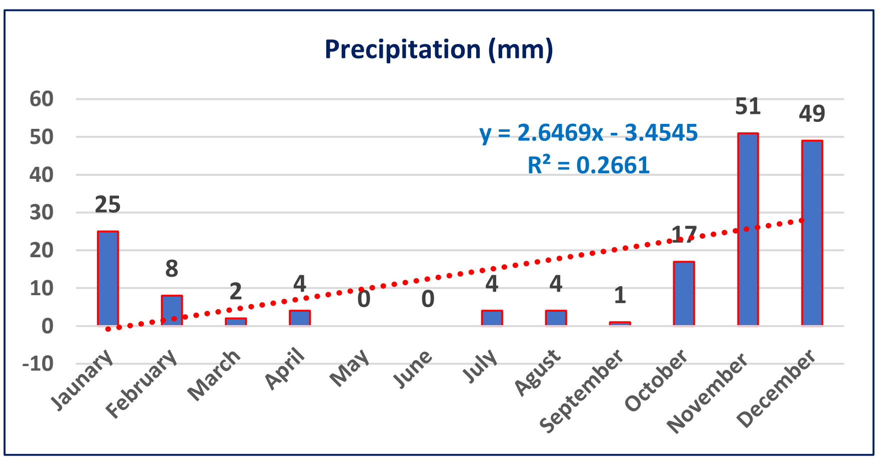

Figure 5. The distributions of Precipitation according to months

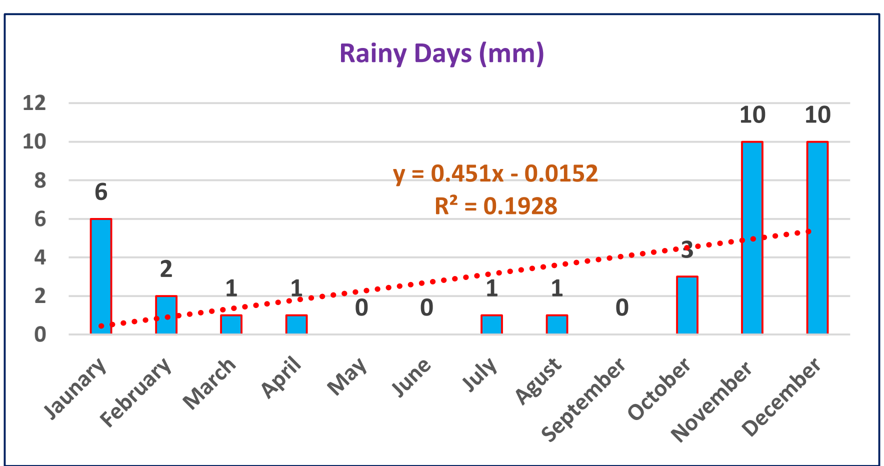

Figure 6. The distributions of Rainy Days according to months

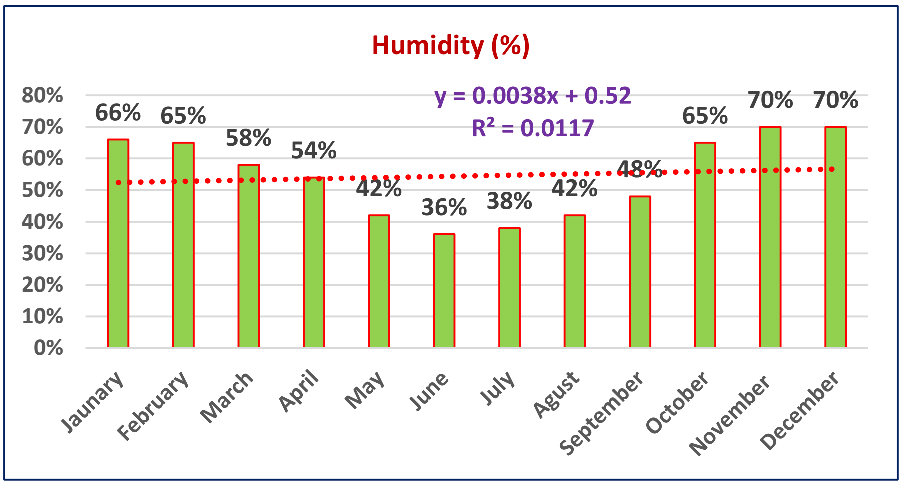

Figure 7. The distributions of Humidity according to months

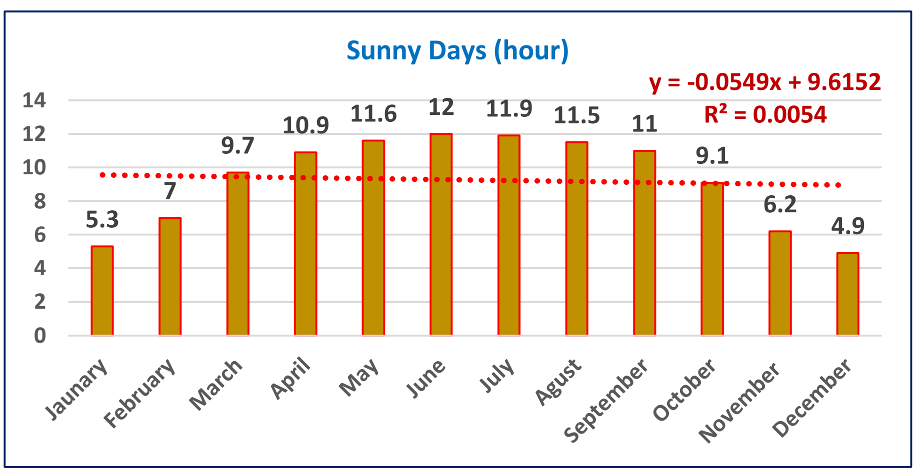

Figure 8. The distributions of Sunny Days according to months

Khartoum is one of the warmest region in Sudan with an average daily high temperature of 38 degrees centigrade. It is yearlong warm or hot. While Red Sea is one of the coldest regions in Sudan with an average daily high temperature of only 35 °C. It is warm to hot all year round, at average water temperatures of 28 degrees (Table 1).

Table 1. The average or total values and Standard deviation of Some Climate Data in Red Sea Region of Sudan

Climate Parameters	Average	Standard deviation
Min. Temperature (°C)	23.63	3.4820
Max. Temperature (°C)	33.08	5.5406
Average Temperature (°C)	28.37	4.4903
Precipitation (mm) (Total)	165.00	18.4988
Humidity (%)	0.55	0.1285
Rainy Days (Total)	35	3.7040
Sunny Hours (hour)	9.26	2.6980

Analysis of Fish Production Data in red sea

The Red Sea's yearly marine capture is less than 1500 tons. Red bass, jack, mullet, and sardinella make up the majority of the catch. Port Sudan is the principal landing location. The major tools utilized are headlines, beach seines, and gillnets. The Red Sea is also used for mother-of-pearl and trochus shell fishing. There is also small-scale commercial shrimp fishing. However, statistics on fisheries and biomass are lacking, thus efforts should be made to increase output in order to satisfy domestic demand and enhance exports. Figure 9 shows fish production in the study area. The figure shows the fluctuation in the volume of production, which is due to many factors, perhaps the most prominent of which is climate change, which has become a major issue threatening fisheries all over the world, in addition to the fact that the Red Sea is one of the warmest and saltiest seas in the world. Water exchange occurs only in the south, and there is moderate variability in nutrients at macro-environmental levels.

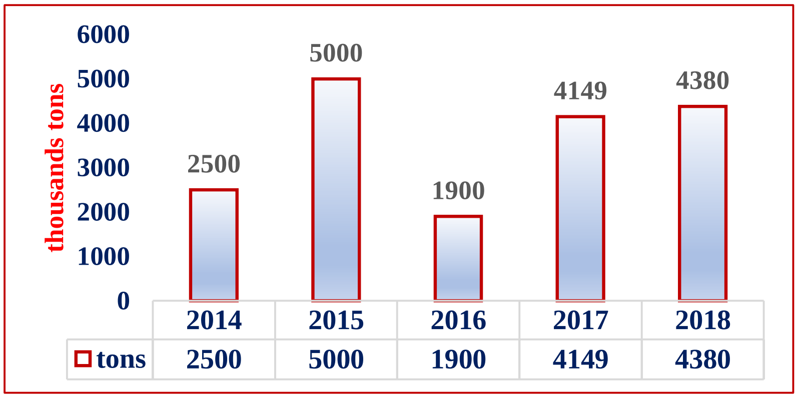

Figure 9. Fish Production in the study area. (Ministry of Livestock and Fisheries, Sudan 2018)

Fisheries are a major source of food for the majority of poor and vulnerable communities in Sub-Saharan African countries. The sector also provides jobs to many men and women and is one of the most traded food commodities in the region. However, the region's fisheries are seriously threatened by climate change. Physical and biological changes are the two categories used to classify possible effects of climate change on fisheries;

Physical changes include increases in sea level, water salinity, and water temperature; biological changes include shifts in primary production and the distribution of fish stocks (Mohammed & Uraguchi, 2013). According to the greenhouse gas emission scenario and the model forecasts for marine regions, the world's exclusive economic zones' maximum catch potential would both decline by 2050 by between 2.8 and 5.3 percent and between 7.0 and 12.1 percent, respectively (Barange et al., 2018).

CONCLUSION AND RECOMMENDATIONS

World has been threatened by climate change under the effect of increased carbon emission and greenhouse gas. Carbon is one of the basic elements of life and shows search without being fixed. The amount of CO_2 reduces the protective use of the bard layer. With this effect, it causes irregular precipitation and excessive temperature increases (Bağdatlı and Arıkan, 2020).

Population growth rate along with the climate change phenomenon will cause lots of problems for worldwide food supply and we will face numerous nutritional problems in the near future. By gradually reaching to the 8 billion population on the earth, the mankind is really in challenge to provide the growing population food needs (Bağdatlı et al., 2015)

There is always the critical importance of aquaculture and fisheries to the millions of people who rely on them to maintain a fair quality of living. However, climate change poses a significant threat to fisheries in the region. If the industry is to continue helping the world achieve its objectives of reducing poverty and ensuring food security, it must pay special attention to those who are most vulnerable to the effects of climate change when implementing adaptation strategies. The highest temperature may be a more pertinent feature in respect to some particular concerns, but most assessments concentrate on the mean seawater temperature. For instance, when temperatures rise over an organism's thermal threshold, thermal collapse occurs. It consequently depends on the highest temperature the organisms encounter rather than the mean temperature. In the Red Sea, where maximum seawater temperatures are already very high, this could be especially crucial. Future monitoring and research must be intimately connected to responsive, adaptive, and reflexive management systems in order to adapt to the changing environment.

Climate change and global warming are reducing the available water resources almost everywhere in the world (Uçak and Bağdatlı, 2017). Excessive increase and decrease of temperatures negatively affect the life of living things. It will be difficult to find clean water in the future as the increase of temperatures will increase the evaporation level. Increasing or falling temperatures will cause climate change (Bağdatlı and Can, 2020).

REFERENCES

Albut S., Bağdatlı M. C. & Dumanlı Ö. 2018. Remote Sensing Determination of Variation in Adjacent Agricultural Fields in the Ergene River, *Journal of Scientific and Engineering Research,* 5(1): 113-122.

Barange M., Bahri T., Beveridge M. C., Cochrane K. L., Funge-Smith S. & Poulain F. 2018. Impacts of climate change on fisheries and aquaculture: synthesis of currrent knowledge, adaptation and mitigation options. FAO.

Bağdatlı M.C. & Belliturk K. 2016a. Negative Effects of Climate Change in Turkey, *Advances in Plants & Agriculture Research*, Med Crave Publishing, 3(2):44-46

Bağdatlı M.C & Belliturk K. 2016b. Water Resources Have Been Threatened in Thrace Region of Turkey, *Advances in Plants & Agriculture Research*, MedCrave Publishing, 4(1):227-228.

Bağdatlı M. C. & Arıkan E. N. 2020. Evaluation of Monthly Maximum, Minimum and Average Temperature Changes Observed for Many Years in Nevsehir Province of Turkey, *World Research Journal of Agricultural Science (WRJAS),* 7(2):209-220.

Bağdatlı M.C. Belliturk K. & Jabbari A. 2015. Possible Effects on Soil and Water Resources Observed in Nevşehir Province in Long Annual Temperature and Rain Changing, *Eurasian Journal of Forest Science*, 3(2):19-27.

Bağdatlı M. C. & Can E. 2020. Temperature Changes of Niğde Province in Turkey: Trend analysis of 50 years data, *International Journal of Ecology and Development Research*

Belkin I. M. 2009. Rapid warming of large marine ecosystems. *Progress in Oceanography,* 81(1-4), 207-213.

Béné C., Neiland A. E. 2003. Valuing Africa's inland fisheries: Overview of current methodologies with an emphasis on livelihood analysis.

Chaidez V., Dreano D., Agusti S., Duarte C. M. & Hoteit I. 201). Decadal trends in Red Sea maximum surface temperature. *Scientific reports*, 7(1), 1-8.

FAO 2019. Fishery and Aquaculture Country Profiles, Sudan 2019. Country Profile Fact Sheets. In: FAO Fisheries Division [online]. Rome. Updated Feb, 2020. [Cited June 29, 2022]. https://www.fao.org/fishery/en/facp/298

Heck S., Béné C., Reyes-Gaskin R. 2007. Investing in African fisheries: building links to the Millennium Development Goals. *Fish and Fisheries*, 8(3), 211-226.

İstanbulluoğlu A. Bağdatlı M. C. & Arslan C., 2013. Uzun Yıllık Yağış Verilerinin Trend Analizi ile Değerlendirilmesi Tekirdağ-Çorlu İlçesi Uygulaması, *Tekirdağ Ziraat Fakültesi Dergisi,* 10(2):70-77, Tekirdağ

Matthews E., Bechtel J., Britton E., Morrison K. & McClennen C. 2014. A gender perspective on securing livelihoods and nutrition in fish-dependent coastal communities.

Ministry of Livestock and Fisheries, Sudan, 2018. Fish Production by Regions (2014-2018) Annual Statistical Journal of the Ministry of Livestock and Fisheries, Sudan. Issue 28 page 47

Mohammed E. Y. & Uraguchi Z. B. 2013. Impacts of climate change on fisheries: Implications for food security in Sub-Saharan Africa. Global Food Security, Nova Science Publishers, Inc, 114-135.

Raitsos D. E., Hoteit I., Prihartato P. K., Chronis T., Triantafyllou G. & Abualnaja Y. 2011. Abrupt warming of the Red Sea. Geophysical Research Letters, 38(14).

Rasul N., Stewart I. C., Nawab Z. A. 2015. Introduction to the Red Sea: its origin, structure, and environment. In The Red Sea (pp. 1-28). Springer, Berlin, Heidelberg.

Rezaeianzadeh M., Tabari H., Arabi Yazdi A., Isik S., Kalin L. 2014. Flood flow forecasting using ANN, ANFIS and regression models. *Neural Computing and Applications,* 25(1), 25-37.

Salihi P. B. A., Üçler N. 2021. The Effect of The Data Type on Anfis Results, Case Study Temperature and Relative Humidity. *Journal of Scientific Reports-A,* (046), 14-33.

Tesfamichael D. & Elawad A. N. 2016. Sudan. In The Red Sea Ecosystem and Fisheries pp. 37-48. Springer, Dordrecht.

Tesfamichael D. & Elawad A. N. 2016. Sudan. In The Red Sea Ecosystem and Fisheries (pp. 37-48). Springer, Dordrecht.

Uçak A. B. & Bağdatlı M.C. 2017. Effects of Deficit Irrigation Treatments on Seed Yield, Oil Ratio and Water Use Efficiency of Sunflower *(Helianthus annuusL.), Fresenius Environmental Bulletin,* 26(4): 2983-2991, *(IJEDR),* 6(2):62-71

UNIDO, 2017. Building institutional capacities for the sustainable management of the marine fishery in the Red Sea State, Republic of Sudan. Unido Independent Evaluation Division Independent Mid-Term Evaluation. SAP ID 130130, Vienna [Cited Tuesday, June 29th 2022]. https://www.unido.org/sites/default/files/2017-03/MTE_Sudan_Marine_fishery_Red_Sea_State_130130_2016_0.pdf