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INFLUENCE OF HUMAN ACTIVITIES ON THE PHYTOPLANKTON COMMUNITIES OF RIVER RIMA IN KWALKWALWA AREA OF SOKOTO STATE, NIGERIA

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ABSTRACT
The studies on influence of human activities on the phytoplankton communities of River Rima in kwalkwalawa area of Sokoto State, Nigeria was carried out from April 2016 to September 2016, with the aim to determine the physiochemical parameters and phytoplankton diversity of the River. The river was divided into four stations; station A (washing and construction site), B (Fishing activities), C (Farming and irrigation site) and D (Undisturbed area). The parameters were determined using standard methods, procedures and instruments. The result revealed that water temperature (35±0.01°C), PH (7.8±0.1), Turbidity (5.0±0.1NTU), Bicarbonates (1.8±0.1mg/l), Chloride (1.33±0.12mg/l), Dissolve Oxygen (6.9±0.1mg/l), Biochemical oxygen demand (31.1±13.72mg/l), Sodium (3.0±0.1mg/l), Potassium (0.9±0.22mg/l), Phosphorus (6.84±11.39mg/l), Nitrogen (0.7±0.26mg/l), Nitrate (1.4±0.02mg/l), Ammonia (1.2±0.01mg/l), Calcium (0.92±0.11mg/l), Magnesium (0.9±0.22mg/l) varied with month and seasons ($P \leq 0.05$). The result of phytoplanktons indicates that five groups were identified Chlorophyta, Baccillariophyta, Cyanophyta, Diatoms and Rhodophyta. Chlorophyta are the most diverse and abundant group. The river is influenced by anthropogenic activities such as runoffs of inorganic fertilizer and pesticides, fishing. The water in the river is used for irrigational and domestic purposes; hence there is need for an effective anthropogenic inputs control progrmme in the river.

Keywords: River Rima; Phytoplanktons; Kwalkwalawa Community; Human activities.

INTRODUCTION

Phytoplankton communities are key components in determining ecosystem stability, and they provide classical examples of abrupt shifts in lakes and reservoirs. Palaeolimnological records have shown that climate change and human activities are important drivers of phytoplankton regime shifts, yet the time intervals can at times be too coarse given changes in sedimentation rate (Yang, *et al.,* 2017, Zhang *et al*., 2018). Limnology studies freshwaters through integration of physical, chemical and biological aspects. It describes and manages freshwater ecosystems. It also covers geological and the attributes of all inland waters (Mokaya *et al*., 2004, Álvarez-Góngora & Herrera-Silveira, (2006). Limnologists work on lakes and reservoir management, water pollution control, stream and river protection, artificial wetland construction, and fish and wildlife enhancement (Primavera, (2006). Surface waters from streams, rivers and river basins have supported human habitations from time immemorial. Rivers are the most important freshwater resources for humans. Social, economic and political development has been largely related to the availability and distribution of fresh water riverine system (Pecl, 2017). Rivers are open dynamic ecosystems whose physical, chemical and biotic characteristics are greatly influenced by anthropogenic activities taking place within their drainage basins (Mokaya *et al*., 2004).

A number of rivers and streams flow through urbanized areas across the world and are profoundly impacted by changes associated with urbanization. Such urban flowing rivers, often occurring at low lying points of the landscape are particularly sensitive and prone to pollution from urban development and other anthropogenic activities which result in increased pollutant load through surface runoff (Bernhardt & Palmer, 2007). Phytoplanktons are photosynthetic, free floating microscopic organisms that live in aquatic ecosystems (Reilly, 2012). They are the autotrophic components of the plankton community and a key factor of freshwater basins ecosystem which inhabit the upper sunlit layer of almost all oceans and bodies of fresh water.

Kwalkwalawa community is one of the largest through which River Rima flows in Sokoto State. Several human activities such as farming, irrigation, fishing, construction, waste disposal, domestic washing of clothes and cars coupled with vehicular emissions from the road that passed across the river to the main campus of Usmanu Danfodiyo University Sokoto have been taking place within the river for decades. Such activities affect both the physical, chemical and biological features, to this end there is need to assess the influence of human activities on the limnology of River Rima thorough analyses of physical and chemical properties and identification of phytoplankton (Awogbemi & Komolafe, 2011; Shinkafi *et al*., 2013; Isah *et al.,* 2017).

MATERIALS AND METHOD

Study Area

The study was conducted in River Rima of Wamakko Local Government Area of Sokoto State. Sokoto State is located in the Sudan savanna in the extreme northwest part of Nigeria between longitude 4°8'E and 6°5'E and latitude 12°N and 13°58'N. Rainfall in the area is between May/June to early October (Mamman, 2000). River Rima flows in the southwestern direction over 100km and join the river Sokoto to form the Sokoto Rima River system. The Sokoto Rima River flows south westerns in a direction up to Zogirma, where it changes direction and run southwards before emptying into river Niger (Shinkafi 2010; Shinkafi 2012; Shinkafi, 2013).

Sampling Stations
After the preliminary survey of River Rima for sampling collection, four sampling stations (A, B, C and D) were selected randomly. Two seasons were observed (dry and rainy season).

STATION A: Washing and construction site, with the following coordinates; Latitudes 13º.6'.236N, longitudes 5º.12.356'E, and altitude 235.

STATION B: Fishing activities. (Latitude 13º.6.138'N, longitude 5º.12.19'E and altitude 239).

STATION C: Farming and irrigation site, (latitude 13º.6.114'N, longitude 5º.12.125'E and altitude 236).

STATION D: Undisturbed area, (latitude 13º.6.056'N, longitude 5º.12.065'E and altitude 243).

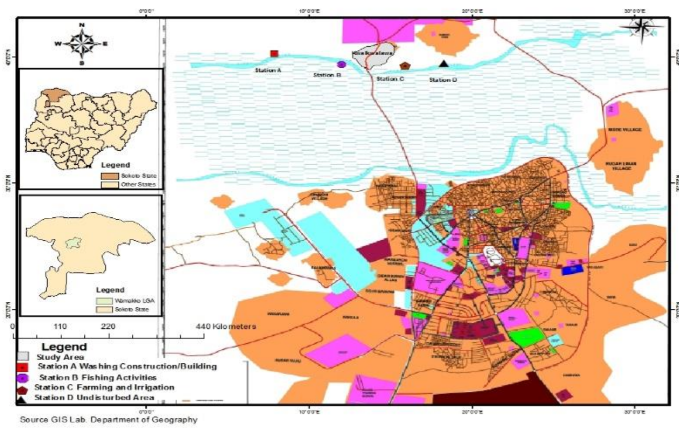

Figure 1: Map of River Rima showing the Sampling Stations (A, B, C and D)

Sample Collection
Sampling at the selected stations was carried out monthly, for period of six months. Water, phytoplankton and macro invertebrates were collected from these sampling stations for the period of the study.

Water Sample Collection
One-liter capacity plastic bottle was used to collect water samples. The bottle was immersed into the river to collect water at the hypolimnion layer early in the morning. Temperature and transparency of the water were measured immediately at the field by the use of mercury in glass thermometer and Secchi disc respectively. Water sample collected was taken to Agric chemical laboratory Usmanu Danfodiyo University, Sokoto, for the determination of the physico-chemical parameters. Analysis for the physicochemical parameters of the water samples was made following the standard methods for the examination of water and waste water (APHA, AWWA & WEF, 1998).

Collection of Phytoplankton
Standard plankton net for surface layers was used. It's conical in shape and has a net ring made up of stainless steel round in shape with mouth size 25cm in diameter. A nylon material was attached to it (which is the filtering portion of the net). A glass jar (50cl) was tied with a cotton rope by the end of the net (Somshekar, 2004). The net handle was dropped over the water and water sample was collected by walking back and forth with the net in the water. The content of the bottle (glass jar), was then transferred into the sample bottle and few drops of 10% formalin were added to preserve the phytoplankton (Magami *et al*., 2014; Magami *et al*., 2015; Maishanu *et al*., 2018).

Statistical Analysis
Raw data obtained was subjected to statistical analysis. Monthly data was subjected to analysis of Variance (ANOVA) and least significant difference (LSD) was used for separation of means.

RESULTS

Physicochemical Parameters
The mean values of physicochemical parameters at different sampling stations in River Rima during the period of the study, (April 2016–September 2016) are presented below. The concentrations of the various water physical and chemical parameters were found to vary with the sampling stations and months.

p^{H}
The pH of the analyzed samples across the four stations during the period of the study is shown in Fig 2. The highest pH value was obtained in the month of August (7.8 ± 0.1) at station B, while the lowest pH value was 6.1± 0.1 and was obtained in the month of May at station B. No significant difference (P<0.05) was observed in the pH of the four stations during the period of the study.

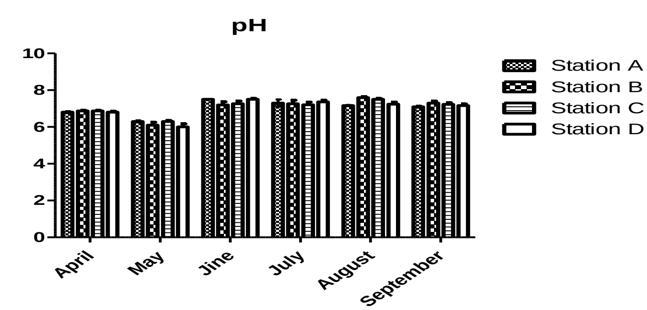

Figure 2: Monthly variation of p^{H} across the four station during the period of the study.

Temperature
The temperature (^{0}C) of the collected water sample showed the highest value of 35^{0}C in June and July at station C, while the lowest temperature was recorded in station A with average value of 23^{0}C in the month of September Fig 3. However, the results differ significantly (P <0.05).

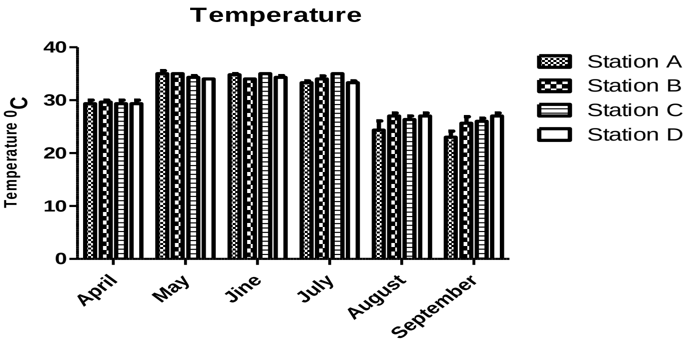

Figure 3: Monthly Variation of Temperature across the four stations during the period of the study

Transparency
The transparency of the collected water samples across the four station shows that there is high turbidity in both the months of August and September. The lowest transparency was recorded in April at 2.36±0.06 in station B. The results indicate a significant difference with the season.

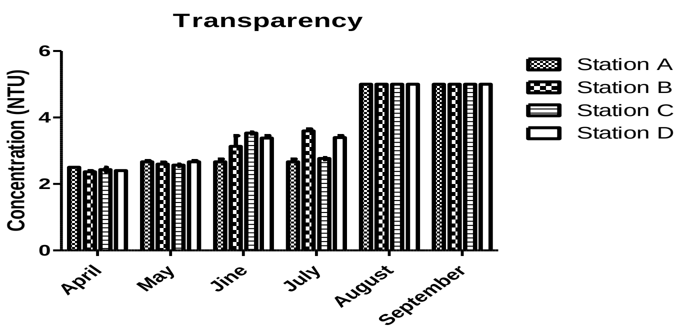

Figure 4: Monthly Variation of Transparency during the period of the studied

Dissolved oxygen (DO)
Dissolved Oxygen of the collected water sample shows highest values of 6.9±0.1 in July at station B. Dissolved Oxygen was recorded low in April at station A and B (1.9±0.2), (1.9±0.1) are shown (see Fig 5). However, dissolved oxygen indicated a significant difference during the period of the study.

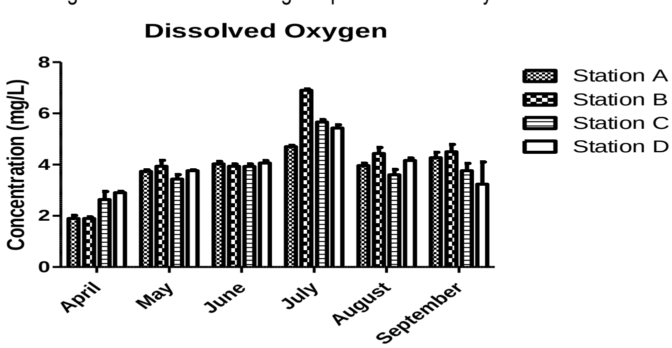

Figure 5: Monthly Variation of DO during the period of the studied

Biochemical Oxygen Demand
Figure 6 shows the result of BOD during the period of the study. BOD was found to be highest in April at station C with a mean value of 31.1±13.72 and lowest value was found to be 14.5±0.37 at station D in May. The results differ significantly (p<0.05).

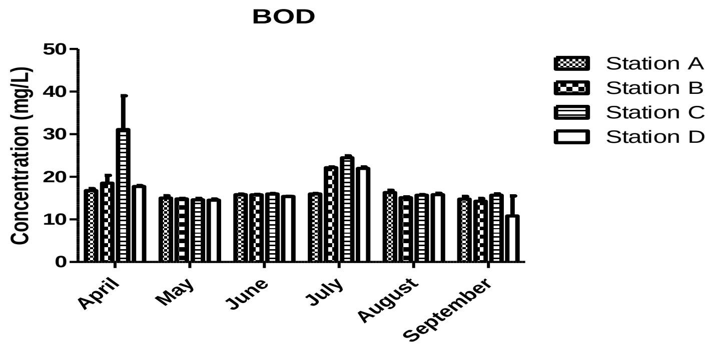

Figure 6: Monthly Variation of BOD

Calcium
Calcium of the analyzed samples across the four stations during the period of the study is shown in Figure 7. The highest value was obtained in the month of June (0.92±0.11) at station D, while the lowest mean value was (0.22±0.79) in September at station D.

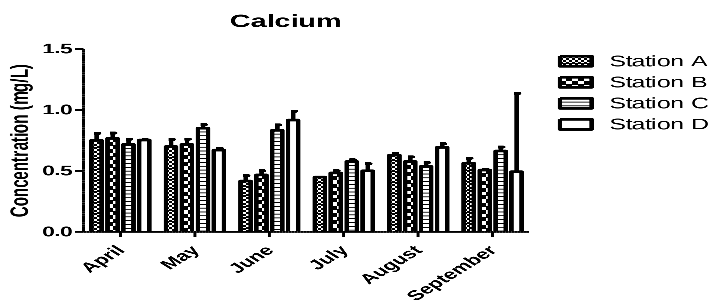

Figure 7: Monthly Variation of calcium during the period of the studied

Magnesium
Figure 8 shows the result of Magnesium. The highest mean value of magnesium was recorded at station A (0.9±0.22) while the lowest mean was recorded in May at station C (0.21±0.10). There was significance difference during the period of the study.

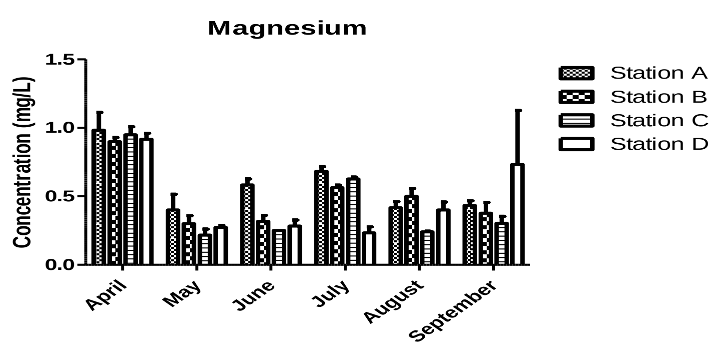

Figure 8: Monthly variation of Magnesium during the studied periods

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Nitrate (NO_3)

Nitrate has shown that there is significance difference during the period of the study. The highest mean value was recorded at station B in August 1.4±0.02. The lowest mean value was found at station A in July with a mean value of 0.4±0.06.

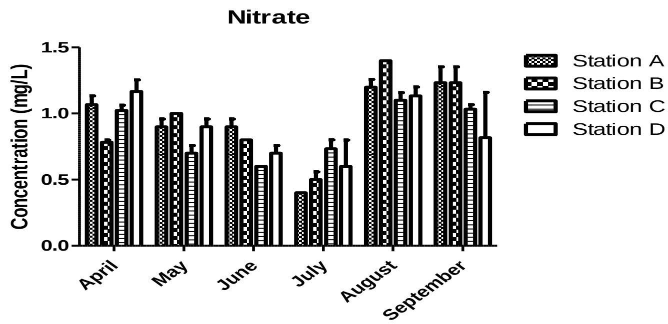

Figure 9: Monthly Variation of Nitrate.

Ammonia (NH_4)

Figure 10 shows the analyzed result of Ammonia. The highest value was recorded at station A in July, with a mean of 1.2±0.01 and the lowest mean was found at station A in September 0.35±0.07. The results differ significantly ($p<0.05$).

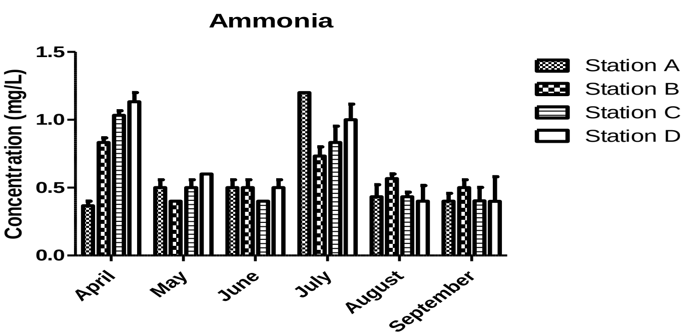

Figure 10: Monthly Variation of Ammonia

Bicarbonates (HCO_3)

The bicarbonates result of the analyzed samples within the four stations during the period of the study is shown in Fig 11. The highest bicarbonates value was recorded in the month of June with the value of 1.8± 0.1 at station D and the lowest is shown in May and July at 1.3±0.1 in station A and C. The result shows significant differences in both the stations.

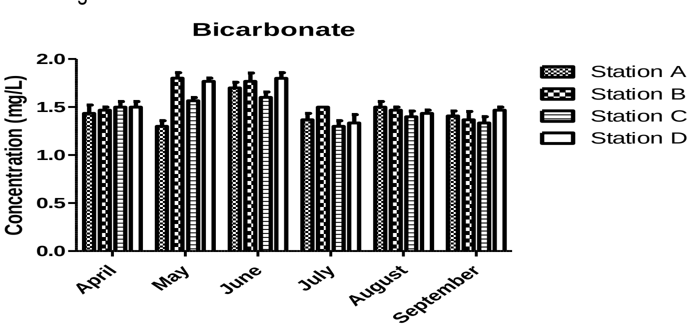

Figure 11: Monthly and seasonal Bicarbonate variations during the period of the studied.

Potassium (K)

Figure 12 shows that the result of potassium. Station A in April has the highest value of 3.53±0.35 and lowest value was in June at station A 0.9±0.1. The result differs significantly.

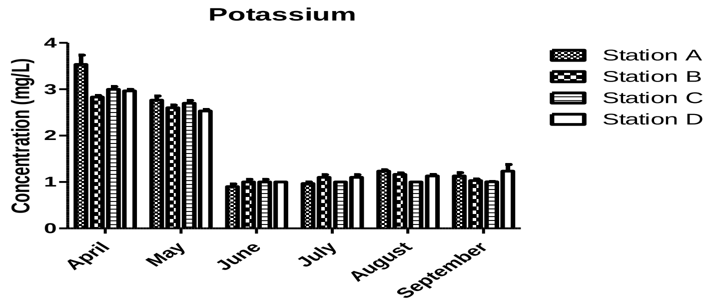

Figure 12: Monthly Variation of potassium across the stations during the studied period.

PHYTOPLANKTON

The phytoplankton species identified in the study area include members of five groups: Chlorophyta, Baccillariophyta, Cyanophyta, Diatoms and Rhodophyta. This was presented in Tables 1 to 4. Chlorophyta is the most diverse group. Oscillatoria of the group cyanophyta is the most abundant group which were found in all the months except in August. Ulothorix has the highest occurrence of 4 in September at station A.

Figure 13, it shows the monthly abundance of Phytoplankton across the four stations studied. Stations A and B in the month of May have the highest number of abundance. Station A and D in April, and station C in August have the lowest number of abundance.

Table 1: Phytoplankton Identified in Station A (2016).

Groups	Species	April	May	June	July	August	September
Bacillariophyta	*Sarcina*	-	-	-	-	-	-
	Synedra	-	-	-	-	-	-
Chlorophyta	*Oedogonium*	1	-	-	-	-	-
	Algae	-	-	-	-	-	-
	Rhizoclonium	-	2	-	-	3	-
	Spirogyra	-	-	-	-	-	-
	Dedogonium	-	-	-	-	-	-
	Ulothrix	-	-	-	-	-	4
	Microspora	-	-	-	-	-	-
	Chaetophora	-	-	2	3	-	-
	Vaucheria	-	-	1	-	2	-
Cyanophyta	*Oscillatoria*	3	2	-	-	-	3
	Phormidium	1	-	-	-	-	-
	Anabana	-	4	-	-	-	-
	Lyngbya	-	-	2	-	-	-
	Aphanizomenon	-	-	-	-	-	-
	Rivularia	-	-	-	-	-	-
	Tolypothrix	-	-	-	-	-	-
Diatom	*Surirella*	-	-	-	-	-	-
	Tabellaria	-	-	-	-	-	-
	Dinobryon	-	-	-	-	-	-
	Nitzschia	-	-	-	-	-	-
	Asterionella	-	-	-	-	-	-
Euglenophyta	*Euglenoids*	-	-	3	-	-	-
Rhodophyta	*Compsopogon*	-	-	-	2	-	2
	Auduinella	-	-	-	-	-	2
	Lemanea	-	-	-	-	-	-

Table 2: Phytoplanktons Identified in Station B (2016).

Groups	Species	April	May	June	July	August	September
Bacillariophyta	*Sarcina*	-	-	-	-	-	-
	Synedra	-	-	-	-	-	-
Chlorophyta	*Oedogonium*	-	-	-	-	-	-
	Algae	-	-	2	-	-	2
	Rhizoclonium	-	-	-	-	-	-
	Spirogyra	-	3	-	-	-	-
	Dedogonium	-	2	-	-	-	-
	Ulothrix	-	-	-	-	-	-
	Microspora	-	-	-	-	-	-
	Chaetophora	-	-	2	-	2	-
	Vaucheria	-	-	-	-	-	-
Cyanophyta	*Oscillatoria*	-	4	-	2	-	-
	Phormidium	1	-	-	-	-	-
	Anabana	-	-	-	-	-	-
	Lyngbya	-	2	-	-	-	2
	Aphanizomenon	-	-	-	-	-	-
	Rivularia	-	-	-	-	-	-
	Tolypothrix	-	-	-	-	-	-
Diatom	*Surirella*	2	-	-	-	-	-
	Tabellaria	-	-	-	-	3	-
	Dinobryon	-	-	-	-	-	-
	Nitzschia	-	-	-	-	-	-
	Asterionella	-	-	-	-	-	3
Euglenophyta	*Euglenoids*	-	-	-	3	-	-
Rhodophyta	*Compsopogon*	-	-	-	-	-	-
	Auduinella	-	-	-	-	-	-
	Lemanea	-	-	-	-	-	-

Table 3: Phytoplanktons Identified in Station C (2016).

Groups	Species	April	May	June	July	August	September
Bacillariophyta	*Sarcina*	-	2	-	-	-	-
	Synedra	-	1	-	-	-	-
Chlorophyta	*Oedogonium*	-	-	-	-	-	-
	Algae	-	-	-	-	-	-
	Rhizoclonium	-	-	-	-	-	-
	Spirogyra	-	-	-	-	-	-
	Dedogonium	-	-	3	-	-	-
	Ulothrix	-	-	-	-	-	3
	Microspora	-	-	-	-	-	-
	Chaetophora	-	-	1	-	-	-
	Vaucheria	-	-	-	2	-	-
Cyanophyta	*Oscillatoria*	-	-	2	-	-	-
	Phormidium	-	-	-	-	-	-
	Anabana	2	-	-	-	3	-
	Lyngbya	-	-	-	3	-	2
	Aphanizomenon	-	-	-	-	-	-
	Rivularia	-	-	-	-	-	-
	Tolypothrix	-	-	-	-	-	3
Diatom	*Surirella*	-	-	-	-	-	-
	Tabellaria	2	-	-	-	-	-
	Dinobryon	-	-	-	-	-	-
	Nitzschia	-	3	-	-	-	-
	Asterionella	-	-	-	-	-	-
Euglenophyta	*Euglenoids*	-	-	-	-	-	-
Rhodophyta	*Compsopogon*	-	-	-	-	-	-
	Auduinella	-	-	-	-	-	-
	Lemanea	-	-	-	-	-	-

Table 4: Phytoplanktons Identified in Station D (2016).

Groups	Species	April	May	June	July	August	September
Bacillariophyta	*Sarcina*	-	-	-	-	-	-
	Synedra	-	-	-	-	-	-
Chlorophyta	*Oedogonium*	-	-	-	-	-	-
	Algae	3	-	-	-	-	3
	Rhizoclonium	-	-	-	-	-	-
	Spirogyra	-	-	-	-	-	-
	Dedogonium	-	-	-	-	-	-
	Ulothrix	-	-	-	-	2	-
	Microspora	-	-	-	-	-	2
	Chaetophora	-	2	-	-	-	-
	Vaucheria	-	-	3	3	-	-
Cyanophyta	*Oscillatoria*	-	-	-	-	-	-
	Phormidium	-	-	-	-	-	-
	Anabana	-	-	-	-	-	-
	Lyngbya	-	3	-	-	-	-
	Aphanizomenon	-	1	-	-	-	-
	Rivularia	-	-	2	2	-	-
	Tolypothrix	-	-	2	3	3	-
Diatom	*Surirella*	-	-	-	-	-	-
	Tabellaria	-	-	-	-	-	-
	Dinobryon	-	-	-	-	-	-
	Nitzschia	-	-	-	-	-	-
	Asterionella	-	-	-	-	-	-
Euglenophyta	*Euglenoids*	-	-	-	-	-	-
Rhodophyta	*Compsopogon*	-	-	-	-	-	-
	Auduinella	-	-	-	-	-	-
	Lemanea	-	-	-	-	-	2

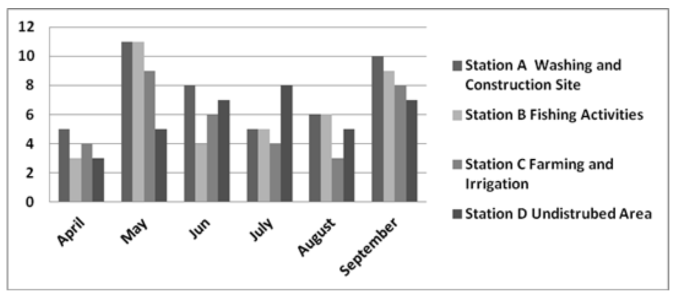

Fig 13: The Monthly abundance of phytoplankton across the four stations

DISCUSSION

The extreme ecological condition of the studied area especially the climatic variation could have resultant effect in modifying River Rima ecosystem (Muhammad, 2017). Fresh water environment, unlike marine is subjected to variations. The ecological parameters such as temperature, pH, total dissolve solid etc. are responsible for distribution of organisms in different fresh water habitation, according to their adaptation and for them to survive in that specific habitat. The study of River Rima shows that pH (hydrogen ion concentration), indicated a slight fluctuation within maximum value recorded (7.8±0.1) in the month of August, similar results was reported by Muhammad *et al*. (2017) in Lake Alau in which higher water temperatures were recorded in August (rainy season) and relatively lower in the dry season. The lowest pH value was (6.1±0.1) in the month of May. The mean temperature values recorded in River Rima during this study is similar to work of Muhammad *et al.* (2017), Idowu *et al.* (2004); Mohammed & Yaji (2013). The temperatures variation of the Lakes falls within the range of 20 – 50°C meant for domestic purposes and for fish production in tropical fresh water. Analysis of variance indicates that there no significant difference (P<0.05, was observed in the pH of the four stations during the period of the study. Ibrahim *et al.* (2009) reported that hydrogen ion concentration (pH) was nearly neutral for both seasons and it was within the range, for inland water pH 6.5-8.5 in Kontagora Reservoir, Niger State, Nigeria.

The phytoplankton species observed in the study area include members of five groups of Chlorophyta, Bacillariophyta, Cyanophyta, Diatoms and Rhodophyta. In general, (Chlorophyta) green algae have higher abundance over other kinds of algae in all stations which indicated the productivity of the river at Kwalkwalawa community especially during wet season, this was a similar finding with that of Maharana *et al*. (2019) who reported that A total of 66 phytoplankton species were from nine different sites under four sectors of Chilika Lagoon. These species belong to Cyanobacteria (11 species), Chlorophyta (25 species), Bacillariophyta (27 species) and Dinophyta (3 species).

Conclusion

All the physicochemical parameters studied revealed monthly variation. The composition of phytoplankton was increased early in the rainy season. The status of the river is influenced by anthropogenic activities as runoffs of inorganic fertilizers and pesticides. The river is used for irrigational and domestic purposes in terms of most of the physicochemical and biological parameters analyzed. The river is a source of drinking water; the potential of the anthropogenic inputs gain significance. There is need for an effective anthropogenic inputs control program in the river.

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