

Socio-Economic Characteristics and Physiochemical Factors Determining Fish Productivity in Madagali Streams and Ponds

Michael Aw

Department of Biological Science Technology, The Federal Polytechnic, Mubi, P. M. B. 35 Mubi, Adamawa State, Nigeria.

Corresponding author: mikeawi2013@gmail.com

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Abstract

There is enough proof that most societies of Nigeria especially the rural communities are confronted with decline in fish productivity of some streams and ponds mostly resulting from desire to have fish on their menu. This study assessed the socio-economic characteristics and some physiochemical factors affecting the sustenance and fish productivity of some streams and ponds in Madagali local government area of Adamawa State, Nigeria. Information on socio-economic characteristics was sourced by administering questionnaire on 120 respondents drawn from five communities (Birishishiwa, Dziel, Kwakwahu, Kwajiti and Pallam). Data collected were analyzed using Descriptive statistics, T-test and analysis of variance while water samples were analyzed using the procedures of American Public Health Association (APHA) and Lovibond comparative kit. Participation by females was higher (74.17%). Statistical comparison of gender participation showed significant difference ($P=4.359$) at 5% level ($p \leq 0.05$). Respondents within the age range of 41-55 years (82%) were the machineries for exploitation of fish resources. The less educated members of the society representing 71.67% of sampled respondents were involved in fishing business. Respondents with comparatively low income (N601,000.00 - N1,300,000.00) constituted the bulk of the respondents (73.34%). The highest fish caught (3,962kg) was recorded in Kwajiti and comparison of fish species productivity statistically showed no significant difference ($P=5.500$) at 5% level. Analysis of the physiochemical factors indicated that values of temperature, pH, dissolved oxygen content, water hardness and turbidity of the Streams and Ponds were within the tolerable level for survival and thriving of freshwater fish species.

Keywords: Fish Productivity, Physiochemical Parameters of Water, Socio-Economic Characteristics, Fish Species, Water Quality, Freshwater Bodies.



Introduction

The status of socio-economic characteristics of man is directly linked to his desire to exploit the environmental resources especially freshwater ecosystem for multiple uses cutting across consumption, irrigation, industrial use, fish harvest and research purposes in

pursuance of improved livelihood. The primary need of man is to have foods that could sustain life thereby making exploitation of natural resources within reach especially fish resource non-negotiable, a situation happening currently in Madagali streams and ponds. The survival of most residents of the study area as subsistence farmers make them overuse the fishery resources through struggle to augment their income. This made fishing business a serious threat to the sustenance of the water bodies.

In addition, the relative high cost of livestock made fish protein as the primary source of animal protein not only in Madagali but in Nigeria as a country (Hussain and Kanwanye, 2023). According to Amos (2019) the current pressure on fishery sector in Adamawa state is becoming severe hence threatening the sustenance of fish protein in the near future.

In Nigeria, 40% of the nation's protein intake is fish, aiding in the achievement of sustainable development goal of feeding the expanding population (Saba *et al.*, 2024). This believe has negatively impacted on the existing water bodies especially Madagali streams and ponds. According to Ogunremi *et al.* (2023) people continue to patronize water bodies for continuous fishing in Nigeria without being cautious of the productive base.

The socio-economic impact of individuals affects the sustenance and productivity of streams and ponds in a complex and multidimensional way and is difficult to comprehend. Gupta and Sharma (2020) stated that socio-economic characteristics such as gender, age and income are major parameters determining the participation of individuals in fishing business. In some society, females participate more than males while others is reverse (Islam *et al.* 2020).

It is an accepted fact that the lower the economic status of individuals, the higher is the position on poverty scale, hence driving individuals to make use of resources without taking into consideration the consequences of the act, of which fish harvest is one. The confronting issue is the continuous loss of aquatic habitat in the study area resulting from incessant demand for farmland and water for irrigation. Furthermore, the increasing pressure on the fish resources fueled by the Boko Haram insurgency that have denied people of Madagali access to the vast farmland along the edges of Sambisa Forest Reserve had significantly contributed to the socio-economic threat acting on the fish resources.

According to Adedeji *et al.* (2017) protection and conservation plan to ensure continuous fish production by water bodies in Adamawa state, which Madagali streams and ponds are inclusive can only be possible through baseline information, that could trigger government interest towards improving the sustainability of water resources of the study area. In Adamawa state, the threats to fishery resources cut across environmental degradation and unsustainable fishing practices that leads to declining fish stocks, habitat loss and other potential conflicts among fishing communities (Amos *et al.*, 2019). To make things worse, herders aids significantly in contaminating the water bodies thereby causing drop in fish production.

Duncan *et al.* (2019) and Van-Meter *et al.* (2016) observed that the pattern of utilization of rivers, streams and ponds by the human population causes the alteration of water quality and most at times the total pollution of the water bodies. Bennett *et al.* (2018) stressed that

man having placed fish on his menu must ensure that the water quality is guaranteed for fish productivity. Good water quality is central in fish production and shall not be overlooked as poor water quality is a limiting factor (Kane *et al.*, 2020). This makes the knowledge of physiochemical parameters of freshwater bodies (streams and ponds) essential to fish productivity and sustainability in the study area. According to Bennett *et al.* (2018) fish makes up almost one-fifth of the total animal protein consumption for over 3.1 billion people globally, making protection of water bodies imperative for human survival.

According to Parmar (2022), the physical and chemical parameters influencing the aquatic environment include dissolved oxygen, turbidity, temperature, pH, water hardness, nutrients and suspended/dissolved solids. For instance, temperature greatly influence the biological activities of fish notably among them behavior, respiration, growth and reproduction (Ibrahim, 2017).

The turbidity (penetration of light), pH (transformation of soluble phosphates), hardness (total soluble Calcium and Magnesium), temperature (the relative heat content) and dissolved oxygen (oxygen content) are all required for productivity of fish which is the primary product of stream and pond that human population yearns for throughout their life time.

It is on this premise that assessment of physiochemical factors of the most utilizable streams and ponds in Madagali local government area of Adamawa state has become inevitable if fish productivity of the stream and other resources alike be sustained. Rabo *et al.* (2023); Boyd *et al.* (2022) and McIntyne *et al.* (2016) all stressed on the importance of stream water fisheries as food source for all segments of the human society hence should be given adequate protection.

Basically, the economic and food security roles played by the streams and ponds for the communities of Madagali local government made the water bodies of primary concern to the residents. This is why there is need for sustenance through provision of adequate information on factors affecting the water bodies, of which physiochemical parameters and socio-economic characteristics are of immense interest. The assessment of the factors will provide the basic information required on the adequacy of the status of physical and chemical properties of water as major parameters determining the aquatic ecosystem productivity especially fish production.

Parmar (2022) emphasized that water quality to a greater extent determines the success or failure of fish production. According to Mustafa *et al.* (2024) and Manalo and Hemavathy (2023), water contaminants reduces fish production because it impairs reproduction, growth and development. Mustafa *et al.* (2024) further stressed that at high concentrations, some contaminants may threaten human health and cause mortality of fish species, thereby reducing stream or pond productivity.

Mustafa and Hossan (2024) and Bashir *et al.* (2020) both acknowledges that the quality of water whether in rivers, streams, lakes, ponds etc. are affected by water chemistry and

sediments existing at the bottom of the water bodies but stressed that human activity contributes significantly to contamination of water bodies through addition of home sewage, pesticides (Chemicals), agricultural fertilizers and other waste from watershed and terrestrial areas.

In Madagali, basic information on the fish productivity of streams and ponds are lacking as there are no written document on fishing activities in the area. In addition, government negligence of the fishery sector in the state has contributed to the loss of important streams and ponds that were once productive. According to the Zonal Fishery Officer, ZFO Michika (2023), Madagali area has lost more than 5 streams to flood and silting triggered by road construction pressure and farming along the banks.

This study assessed the socio-economic characteristics and the water quality of Madagali streams and ponds in order to provide the basic information on the economic status of fishers/respondents and the physiochemical water parameters of Madagali streams and ponds. The information on these determinants of fish productivity in the study area if made available to the government will help in developing strategies for the effective management of the water bodies and increased fish productivity.

Materials and Methods

Study Area

The study was carried out in Madagali local government area of Adamawa state, Nigeria. The local government shares a boundary with Cameroon Republic in the East, Michika local government in the South, Askira/Uba and Gwoza local government areas of Borno State in the West and North respectively. The local government area lies on latitude $10^{\circ} 24^1$ N and longitude $13^{\circ} 48^1$ E with a population of 156, 230 (National Population Commission, NPC, 2016). Below (Fig. 1) map of Adamawa state showing the study area.

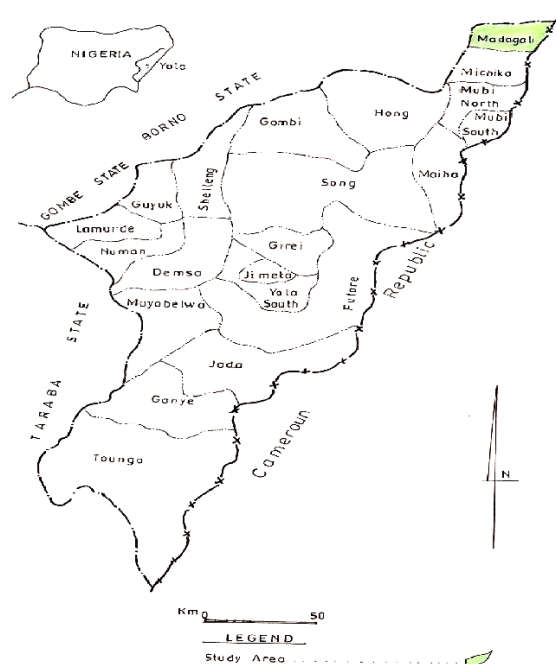


Fig.1: Map of Adamawa State Showing the Study Area

Source : Adebayo (1999)

Materials and Items Required

For the investigation, the following materials/items were used; boot, survey hand gloves, binocular telescope, 100m tape, structured and unstructured questionnaire, depth measurement range, current meter, standard fishing net, machete, digger, survey umbrella, freshwater fish species manual and research recording books etc.

Data Collection

For identification and documentation of existing streams and ponds, the study area was crisscrossed to ease on the spot assessment. Map of Madagali local government area was effectively utilized to enhance the data collection process. The investigation adopted the pre-research process through reconnaissance survey which provided an atmosphere for interaction with the most popular fishers and fish vendors (traders). This process aided in the sampling of the respondents (the fishers).

For assessment of the socio-economic characteristics of support zone dwellers, structured and unstructured questionnaires alongside interview schedule were administered on 120 respondents that consisted of fishers. Respondents of 35 years and above were sampled using simple random sampling technique as outlined by West (2016).

The choice of age range was to ensure that only those that have gotten enough experience on the happenings with regard to fishing were sampled. Interview and group discussions

were equally held with community leaders and other stakeholders through participatory rural appraisal technique as adopted by Wati *et al.* (2020).

Respondents were sampled from five (5) administrative units/communities (Birishishiwa, Dzuel, Kwakwahu, Kwajiti and Pallam). All the listed communities consisted of sub-communities. The sampling adhered strictly to Kareem *et al.* (2015) method of proportional allocation technique with slight modifications, where n_h was replaced by M and N_h replaced by h . The formula is stated as follows;

$$M = \frac{h \times n}{N}$$

Where;

M = number of questionnaire administered in each community

n = total number of questionnaire administered

h = Estimated population of the people in each community

N = total number of people in all the communities

The sample allocation also took into consideration the population of support zone dwellers living close to the streams and ponds from which respondents were drawn as shown in Table 1. The process maintained Cochran (1977) proportional allocation technique as regards the population from which sample was taken. Similarly, the investigation had good representatives of each community that helped in the research result precision. Below (Table 1) is the detail number of respondents drawn from each community on which questionnaire was administered.

Table 1: Number of Respondents per Community on which Questionnaire was Administered

Name of community	Population from which respondents were sampled (h)	Number of questionnaires administered in each community (M)	Percentage (%) of respondents in each community
Kwajiti	348	24	6.90
Pallam	436	31	7.11
Dzuel	272	19	6.99
Birishishiwa	364	26	6.94
Kwakwahu	288	20	6.94
Total	1,708 (N)	120 (n)	

Source: Field Survey (2024) and Awi (2025)

Physiochemical Parameters

The physiochemical parameters of water of 8 Streams and 4 Ponds were analyzed to assess the temperature, dissolved oxygen, pH, water hardness and turbidity.

The water temperature and dissolved oxygen content were measured using American Public Health Association, APHA (1998) for the examination of water and wastewater as adopted by Nicholas (2021).

Water temperature laterally measures how hot or cold water is. For temperature measurement, mercury-in-glass thermometer was used where a glass tube filled with mercury that expands when temperature increases from a scale on the tube, with lower temperature near the bulb and higher temperature near the top. A thermometer of 0-100 Celsius calibration was dipped inside the water sample in a beaker and the reading of the temperature was then recorded.

For assessment of the dissolved oxygen content, the investigation effectively utilized the use of handheld optical dissolved oxygen meter based on Luminescence Technology to determine the dissolved oxygen content of the water bodies through dipping of the meter in the water body and taking the reading (Waste Management Program, WMP (2024).

pH, water hardness and turbidity were measured using Lovibond Comparator kit. Lovibond Comparator system is an extremely versatile modular system for testing physiochemical factors of water (Patil, 2012).

pH is a measure of how acidic or basic a substance is which is measured or reported on a scale of 0 to 14 pH. For measurement of water pH, the pH disc was appropriately fitted into the comparator. 13.5mol/10mol moulded cell were filled to the 10m mark with the sample to be tested and were placed; one cell in the left hand compartment of comparator. To the other cell in the right-hand, appropriate (1 and 2) pH tablets (phenol red for disc 2/1J and bromothymol blue for disc 2/1H) were then crushed and added to the sample.

The cell in the right-hand compartment of the comparator was placed, holding the comparator facing north daylight. The disc was then rotated until the correct colour match was found. The pH value of the solution was then obtained in the bottom right-hand aperture of the comparator. The values gotten were within the ranges of 6.8 - 8.4 for disc 2/1J and 6.0 - 7.6 for disc 2/1H

Water hardness concerns the quantity of dissolved Magnesium and Calcium in water. Water hardness was measured by placing 50ml of raw water into 250ml conical flask, then 4ml of buffer solution (Ammonium Hydroxide) was added. To the mixture, 10drops of 5% hydroxyl-amine-hydrochloride and 10 drops of 2% sodium cyanide were added respectively. Then 5 drops of eriochrome black indicator was added and then titrated with standard 0.01m di-sodium salt of ethylene diamine tetra-acetic acid (EDTA). The hardness was then calculated in grammes per 50ml of water sample.

Turbidity is a parameter used to measure how cloudy or clear water is. It is of utmost importance in assessment of water quality. For determination of turbidity, Fit disc NSA into the comparator, 50ml tube was filled with the sample under test and placed in the right hand compartment of the Nessler 50. The Comparator was fitted unto the Nessler 50, facing North daylight and the disc was allow to rotate until the colour standards matched the sample. The result was read in Hazen units in the bottom right-hand aperture of the comparator.

Water samples were collected from 8 Streams and 4 Ponds visited and were analyzed for assessment of the above parameters.

Results and Discussion

Assessment of Some Socio-Economic Characteristics of Respondents

The socio-economic characteristics examined on the respondents include; gender, age, educational qualification, occupation and annual income as presented in Tables 2, 3, 4 and 5 below respectively.

Gender of Respondents

Table 2 below shows the gender of respondents sampled across the five (5) different communities. The result indicated that majority of the respondents were females (89) representing 74.17% of the sampled population (120 respondents). The relative high number of females participating in fishing and fish business may be connected to their desire to augment the effort of the males who were probably the sole providers.

Other reasons may include; the relative low economic status of females and the fishing business as the only viable business in rural communities may be the driving forces for the females' high level engagement. This finding substantiates the report of Islam *et al.* (2020) that in some society, females participate more than males while others is reverse.

Ndasaya (2021) also emphasized on the importance of fishing business in economic growth and this could be a factor for high participation of females. According to Anyim *et al.* (2021) married women tend to show more interest in fishing and packaging in most rural communities as means of income and daily need.

The study compared gender participation in fish business using T-test and the result indicated that participation of male and female statistically differs significantly because the calculated T-value (4.359) is more than the table-value (2.776) at 5% level of significance where $P \leq 0.05$.

Table 2: Gender (% of Respondents)

Administrative Units	Frequency of Male	Female	Total
Kwajiti	4(16.67)	20(83.33)	24
Pallam	6(19.35)	25(80.65)	31
Dzuel	9(47.37)	10(52.63)	19
Birishishiwa	7 (26.92)	19(73.08)	26
Kwakwahu	5(25.00)	15(75.0)	20
Total	31(25.83)	89(74.17)	120

Source: Field Survey (2024)

*Figures in parenthesis are in percentages (%)

Age Range of Respondents

The pooled result of the age range of respondents (Table 3) showed higher participation by those within the ages of 41-55years representing 68.30% (20.83%, 23.33% and 24.17% respectively). This segment (41-55years) of the society tends to be more active and are

experienced enough to withstand the stress and tediousness of the fishing and fishing business.

This assertion is similar to Ogunremi *et al.* (2023) and Ervik *et al.* (2022) who both reported that experienced and the active segment of the society are the major machineries use for exploitation of our natural resources especially the fishery resources. Similarly, the cultural believe that only vibrant and agile segment of the society can withstand the rigor of fishing business in water bodies may be the reason for high participation by age bracket of 41 - 55years as earlier observed by Ahmed and Hossan (2021).

Furthermore, at 41 – 55 years the fishers are experienced and agile making them physically and mentally fit to undertake the tedious fishing business. Moreover, they utilize their experience through effective use of division of labour to enhance the fishing skill, efficiency and catch success.

Table 3: Age Range (% of Respondents)

Age Class (Years)	Kwajiti	Pallam	Frequency of Dzuel	Respondents Birishishiwa	Kwakwahu	Total
35 - 40	4(16.67)	8(25.81)	2(10.58)	5(19.23)	1(5.00)	20(16.67)
41 - 45	7(29.17)	5(16.13)	4(21.03)	6(23.08)	3(15.00)	25(20.83)
46 - 50	6(25.00)	10(32.20)	3(15.79)	4(15.38)	5(25.00)	28(23.33)
51 - 55	3(12.50)	5(16.13)	7(36.84)	6(23.08)	8(40.00)	29(24.17)
56 - 60	1(4.17)	3(9.68)	1(5.26)	2(7.69)	3(15.00)	10(8.33)
61 - 65	3(12.50)	-	2(10.53)	3(11.54)	-	8(6.67)
Total	24	31	19	26	20	120

Source: Field Survey (2024)

*Figures in parenthesis are in percentages (%)

Educational Qualification of Respondents

The result of educational qualification of the respondents is presented in Table 4 below. The outcome of this study showed that respondents with no formal education (35.89%) and those of primary school (30.83%) constituted the majority of the sampled population. The interpretation of this result shows that the educationally disadvantaged members of the society tend to engage themselves in businesses that will help improve their economic status no matter how difficult the situation is because they are not gainfully employed.

Similarly, those of secondary school (20.83%) are most of the time underemployed therefore they are usually involved in activities that could augment their earnings. The high number of patronage of fishing and irrigation practices shown by this segment of the society agrees with Khatun *et al.* (2018) who highlighted that members of the society with higher levels of education do not seem to participate in fishing as their income may be measurable with their needs.

This finding corroborates Kigbu *et al.* (2014) that the less privileged members of the society are most of the time involved in intensive labor work and usually make use of resources at their reach to ensure survival.

Table 4: Educational Qualification (% of Respondents)

Educational attainment	Kwajiti	Pallam	Frequency of Dzuel	Respondents Birishishiwa	Kwakwahu	Total
No formal education	10(41.67)	12(38.71)	8(42.11)	7(26.92)	6(30.00)	43(35.89)
Primary school	7(29.17)	9(29.03)	5(26.32)	11(42.31)	5(25.00)	37(30.83)
Secondary school	3(12.50)	7(22.58)	4(21.05)	6(23.08)	5(25.00)	25(20.83)
Tertiary	4(16.67)	3(9.68)	2(10.52)	2(7.69)	4(20.00)	15(12.50)
Total	24	31	19	26	20	120

Source: Field Survey (2024)

*Figures in parenthesis are in percentages (%)

Occupation of Respondents

Study carried out to assess the distribution of respondents in fishing and fishing business alongside those actively involved in irrigation practices is presented in Table 5 below. The result indicated that the bulk of the respondents were farmers (86) representing 71.67% of the sampled population. The respondents' distribution across the five communities also showed that majority of them are farmers with Dzuel (63.16%), Kwakwahu (65.00%), Birishishiwa (65.38%), Kwajiti (79.17%) and Pallam (80.64%) representing 12, 13, 17, 19 and 25 respondents respectively.

The relatively large number of respondents being farmers may likely be linked to the close proximity of their farms to the fishing sites and the sufficient time they have for fishing hence there is no cost. In addition, the increased utilization of water resources for irrigation by the communities may be directly connected with the increased demand for food.

According to Gambo and Idris (2018) unprecedented human population increase could be a contributing factor for increased utilization based on the earlier findings on the effect of population growth on food security in Nigeria.

Table 5: Occupation (% of Respondents)

Occupation	Kwajiti	Pallam	Frequency of Dzuel	Respondents Birishishiwa	Kwakwahu	Total
Farmer	19(79.17)	25(80.64)	12(63.16)	17(65.38)	13(65.00)	86(71.67)
Civil servant	3(12.50)	2(6.45)	-	4(15.38)	1(5.00)	10(8.33)
Trader	2(8.33)	4(12.90)	7(36.84)	5(19.23)	6(30.00)	24(20.00)
Total	24	31	19	26	20	120

Source: Field Survey (2024)

*Figures in parenthesis are in percentages (%)

Annual Income of Respondents

Investigation was conducted to assess the annual income of respondents who were actively involved in fishing and fishing business as well as irrigation practices and the result presented below in Table 6. The percentage of respondents sampled within the different annual income ranged from 1.67% for N1,801,000.00 - N1,900,000.00 to 14.17% for annual income range of Ngo1,000.00 – N1,000,000.00 representing 17 respondents. The bulk of the respondents sampled were between the annual income range of N601,000.00 - N1,300,000.00 representing 74.17% (89 respondents).

The relatively low annual income status of the majority of respondents could have probably triggered their mindset towards fishing and fishing business and the irrigational practices. The findings of this study is in line with Asian Development Bank, ADB (2020) report that the low income earners and the relatively poor members of the society are mostly involved in exploitation of natural resources no matter the enormity of the consequences because of the desire to survive.

Table 6: Annual Income (% of Respondents)

Annual income	Kwajiti	Pallam	Frequency of Dzuel	Respondents Birishishiwa	Kwakwahu	Total
N500,000.00 – N600,000.00	-	2(6.45)	-	3(11.54)	-	5(4.17)
N601,000.00 – N700,000.00	1 (4.17)	4(12.90)	3(15.78)	2(7.69)	2(10.00)	12(10.00)
N701,000.00 – N800,000.00	3(12.50)	1(3.25)	1(5.26)	2(7.69)	3(15.00)	10(8.33)
N801,000.00 – N900,000.00	4(16.67)	5(16.13)	-	3(11.54)	2(10.00)	14(11.67)
N901,000.00 – N1,000,000.00	5(20.83)	-	5(26.32)	7(26.92)	-	17(14.17)
N1,001,000.00 – N1,100,000.00	3(12.50)	4(12.90)	2(10.53)	1(3.85)	1(5.00)	11(9.17)
N1,101,000.00 – N1,200,000.00	1(4.17)	6(19.25)	3(15.79)	2(7.69)	1(5.00)	13(10.83)
N1,201,000.00 – N1,300,000.00	2(8.33)	4(12.90)	1(5.26)	1(3.85)	3(15.00)	11(9.17)
N1,301,000.00 – N1,400,000.00	-	2(6.45)	1(5.26)	-	-	3(2.50)
N1,401,000.00 – N1,500,000.00	3(12.50)	1(3.23)	-	2(7.69)	3(15.00)	9(7.50)
N1,501,000.00 – N1,600,000.00	1(4.17)	-	2(10.53)	1(3.85)	2(10.00)	6(5.00)
N1,601,000.00 – N1,700,000.00	1(4.17)	2(6.45)	-	1(3.85)	-	4(3.33)
N1,701,000.00 – N1,800,000.00	-	-	-	1(3.85)	2(10.00)	3(2.50)
N1,801,000.00 – N1,900,000.00	-	-	1(5.26)	-	1(5.0)	2(1.67)
Total	24	31	19	26	20	120

Source: Field Survey (2024)

*Figures in parenthesis are in percentages (%)

Streams and Ponds Investigated in the Study Area

The investigation identified 8 streams and 4 Ponds in different locations as presented in Table 7.

Table 7: Streams and Ponds and their Locations

S/No.	Name of water body	Location
Streams		
1.	Kauye	Kwajiti
2.	Birishishiwa	Birishishiwa
3.	Galamdu	Pallam
4.	Kofor	Dzuel
5.	Gari	Pallam
6.	Imigu Haman	Dzuel
7.	Shuwa	Kwakwahu
8.	Giwa Mblaji	Kwakwahu
Ponds		
1.	Mithildil	Birishishiwa
2.	Evali	Pallam
3.	Zhau	Dzuel
4.	Vami	Dzuel

Source: Field Survey (2024) and Awi (2025)

Fish Species Productivity of Streams and Ponds

The fish species productivity of 8 streams and 4 ponds investigated is presented below in Table 8. The result showed that there was high productivity of *Clarias gariepinus* (African mud catfish), followed by *Clarias lazera* (African catfish) and then *Tilapia zilli*.

The thriving capability of the 3 species above may be connected to their ability to with stand the harsh environmental conditions characterized by high temperature and incessant disturbance by fishers. An observation similar to Parmar (2022) on the role of physiochemical attributes of water in freshwater ponds productivity.

Table 8: Fish Productivity of Streams and Ponds of the study Area for 3 Years (2022 – 2024) in Kilogrammes (% of Respondents)

Scientific name	Kwajiti	Pallam	Frequency of Dzuel	Respondents Birishishiwa	Kwakwahu	Total
<i>Tilapia zilli</i>	587 (14.82)	255 (9.21)	450 (18.79)	385 (10.64)	370 (10.92)	2,047 (12.69)
<i>Clarias lazera</i>	900 (22.72)	765 (27.63)	417 (17.44)	965 (26.74)	816 (24.67)	3863 (23.95)
<i>Synodontis clarias</i>	164 (4.14)	102 (3.68)	155 (6.47)	240 (6.63)	125 (3.69)	786 (4.89)
<i>Oreochromis niloticus</i>	182 (4.59)	116 (4.19)	37 (1.54)	166 (4.59)	45 (1.33)	546 (3.38)
<i>Alestes dentex</i>	20 (0.50)	66 (2.38)	-	67 (1.85)	133 (3.92)	286 (1.77)
<i>Schilbe uranoscopus</i>	98 (2.47)	42 (1.52)	-	55 (1.52)	155 (4.57)	350 (2.17)
<i>Clarias gariepinus</i>	813 (20.52)	995 (35.93)	918 (38.33)	1,065 (29.44)	1,004 (29.63)	4795 (29.72)
<i>Protopterus annectans</i>	203 (5.12)	50 (1.81)	73 (3.05)	150 (4.15)	240 (6.64)	716 (4.44)
<i>Synodontis nigrita</i>	36 (0.91)	25 (0.90)	54 (2.25)	18 (0.50)	25 (0.74)	158 (0.98)
<i>Mormyrus niloticus</i>	345 (8.71)	65 (2.35)	121 (5.05)	85 (2.35)	225 (6.64)	841 (5.21)
<i>Schilbe mystus</i>	524 (13.23)	135 (4.88)	-	200 (5.75)	250 (7.38)	1,117 (6.92)
<i>Schilbe intermedius</i>	-	55 (1.99)	105 (4.38)	71 (1.96)	-	231 (1.43)
<i>Mormyrus longirostris</i>	90 (2.47)	98 (3.59)	65 (2.71)	142 (3.95)	-	396 (2.45)
Total	3,962	2,769	2,395	3,618	3,388	16,132

Source: Field Survey (2024) and Awi (2025)

*Figures in parenthesis are in percentages (%)

Comparison of Fish Productivity of the Streams and Ponds

Fish productivity based on species was compared using analysis of variance (ANOVA) as presented in Table 9. The result statistically showed no significant difference in the quantity of fish produce by species ($P=5.500$) at 5% level of significance. The difference in quantity recorded may be attributed to initial stock reaching the streams or those found in the ponds.

Table 9: Analysis of variance of Fish Productivity based on Species

Sources of variation	D.F	SS	MS	Calculated F	Table F
Trt	12	41,516,838.41	3,827,308.75	5.500	21.025
Error	52	36,184,000.0	695,846.15		
Total	64	77,700,833.41			

Source: Field Survey (2024)

Physiochemical Factors of Stream and Pond Water

The physiochemical factors of stream and pond water that include temperature, pH, dissolved oxygen, hardness and turbidity were assessed as presented in Table 10. These parameters are of utmost importance as determinants of fish growth and productivity in water bodies.

The temperature variation of the 8 streams and 4 ponds ranged from 25.2°C for Mithildil Pond to 26.0°C for Birishishiwa and Galamdu Streams each. The relatively high temperatures recorded in those water bodies may be one of the factors that encouraged the high productivity of *Clarias gariepinus* (African mud catfish) and *Clarias lazera* (African catfish) and similarly the *Tilapia zilli* because these fish species thrives in high temperature environment as reported by Parmar (2022). Similarly, Masood *et al.* (2021) emphasized that temperature ranges within 25 – 36°C provides conducive environment for growth and productivity of most fish species.

The pH of the streams had a narrow range of 7.1 - 7.2 while that of Ponds ranged from 6.6 for Zhau to 7.7 for Evali Pond. These pH ranges are considered adequate for productivity of majority of freshwater fish species (Masood *et al.*, 2021). The result of this investigation is in agreement with the observation made by Demeke and Tassew (2016) that freshwater fish species perform well in water bodies with pH values of 6.5 – 8.5.

This result indicates that all the water bodies although Zhau pond being slightly acidic (pH. 6.6) but they have the required optimal environment for productivity of fish and their utilization for irrigation. The findings of this investigation validate the report of Rabo *et al.* (2023) that freshwater bodies play important role in fish production and protein supply.

The result of investigation of dissolved oxygen (DO) ranged from 5.7mg/l in Gari stream to 6.9mg/l in Galamdu stream. The values of DO recorded across the water bodies where above the minimum of 3.5mg/l as recommended by Demeke and Tassew (2016). This is an indication that freshwater fish species can thrive well despite that they have different requirement for dissolved oxygen concentration. The findings of this study is slightly lower than the recommendation of Kane *et al.* (2020) that dissolved oxygen content within the range of 6.5 - 9.0mg/l encourages the well-being and growth of fish.

The result of water hardness of Streams and Ponds analyzed generally showed that all the waters were soft as the values ranged from 0.02g/50ml – 0.04g/50ml. This study have revealed that the concentrations of calcium and magnesium in the stream and pond waters are within the tolerable levels and can guarantee the safety of the water bodies for

production of fish and human consumption if compared with the categorizing of 0.0 - 75.0mg/l for soft water by Tiwari and Bajpai (2012).

Turbidity of water was measured using colour, true and apparent Hazen 50 with 10 – 500mg/L Pt range adopted by Bennett and Drikas (1993). The result of assessment (Table 10) revealed a range of 10.0 – 30 Hazen. The turbidity range were within acceptable range when compared to the findings of Iwegbue *et al.* (2022) where the values ranged between 20.3 – 42.3 Hazen on study carried out to assess the physiochemical properties of Bomadi Creek in Niger Delta of Nigeria.

Table 10: Assessment of Physiochemical Properties of Stream and Pond Water

S/No.	Water Sample	Location	Temperature (°C)	pH	Dissolved oxygen mg/l	Hardness (g/50ml)	Turbidity (Hazen)
Streams							
1.	Kauye	Kwajiti	25.5	7.2	6.80	0.03	15.0
2.	Birishishiwa	Birishishiwa	26.0	7.2	6.50	0.02	10.0
3.	Galamdu	Pallam	26.0	7.1	6.90	0.03	11.0
4.	Kofor	Dzuel	25.5	7.2	5.80	0.04	10.0
5.	Gari	Pallam	25.7	7.1	5.70	0.04	15.0
6.	Imigu Haman	Dzuel	25.8	7.2	6.10	0.03	10.0
7.	Shuwa	Kwakwahu	25.5	7.2	6.30	0.02	15.0
8.	Giwa Mblaji	Kwakwahu	25.5	7.2	6.40	0.03	15.0
Ponds							
1.	Mithildil	Birishishiwa	25.2	7.2	6.30	0.04	20.0
2.	Evali	Pallam	25.4	7.7	5.80	0.04	30.0
3.	Zhau	Dzuel	25.3	6.6	6.60	0.04	30.0
4.	Vami	Dzuel	25.0	7.2	6.50	0.04	20.0

Source: Field Survey (2025)

NTU = Nephelometric Turbidity Unit

Conclusion

The socio-economic characteristics of respondents and the physiochemical properties of streams and ponds as factors affecting the sustenance and fish productivity of water bodies were assessed. The study revealed that females were more engaged in fishing and fishing business than males, which could be attributed to females' relatively low income status in the society. Age, education, occupation and annual income of respondents had a direct bearing on the number of fishers participating in fishing and fish business in the study area. Generally, the physiochemical properties of streams and ponds cutting across temperature, pH, dissolved oxygen content, water hardness and turbidity were all within tolerable range for freshwater fish species to thrive. Accurate knowledge on the above listed physiochemical properties of water are very important as component for the sustenance of

the productivity of streams and ponds. These factors are considered crucial and core in fish productivity. It is also important to acknowledge that the physiochemical properties of water bodies at their ideal levels make aquatic ecosystems productive and healthier for the survival of different species of fish.

Recommendations

Based on the study carried out, it is recommended that;

- i. Awareness be created among the local residents/fishers that water pollution or contamination should be avoided.
- ii. There is need for sustainability of the present state of physiochemical properties of the water bodies for continuous fish productivity

Limitation of the Study

Financing the research and the level of formal education of the respondents were the major limiting factors.

Future Research Endeavour

There is need for future studies on the reasons why some species tend to show low productivity compare to others despite the environment within which they live is optimal.

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