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Research Article

Assessment of River Water Quality and Pollution Status Using Physicochemical and Biometrics, Awetu River, Ethiopia

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The surface water is contaminated by a variety of synthetic organic and inorganic compounds, chemicals, and nutrients; due to this reason, the quality of the water resources of Ethiopia is declining at an alarming rate, resulting in severe environmental degradation. The main objective of the study was to recognize the pollution status river for the study area by physicochemical parameters and the extent of microbial environmental matrices. The experiment was conducted using a complete randomized model with three composite replicates in each site, and water samples were collected from six different sampling sites using the American Public Health Association (APHA) technique. Water quality parameters were analyzed by the standard method of examination, whereas same examination was determined on site (in situ) (pH, Temp, Conductivity, and Turbidity), whereas TSS, COD, BOD, nitrate, alkali, and orthophosphate were identified in the laboratory. The relationship between physicochemical and benthos assemblages as bio indicators of ecohydrological river water quality was investigated using Spearman's median rank correlation. The output of the study reveals that there was a negatively significant difference in effect between the sample and all the sites of the river. Physicochemical results of the river indicate Temp (23.62), EC (101.42), nitrate (2.175), and orthophosphates (0.081) were below the standard guidelines; however, turbidity (8.41), BOD (784.5), and alkali (396.5) were above the standard. Same of the water quality values for this study were ranges within the standard, DO (5.11), and pH (7.66). The benthos assemblage communities of the ecohydrological area were more influenced by the influents, and the macroinvertebrate index of all sample sites indicates the Shannon and Simpson diversity indices; result shows that the river was lightly polluted.

1. Introduction

Water is the most important natural resource in the world since life cannot exist and industry cannot operate without water [1], and unlike many other raw materials, there is no substitute for water in many of its uses [2–5]. The health and wellbeing of a population are directly affected by the coverage of water supply and sanitation. The impact of poor environmental conditions urbanization is one of the main causes of environmental problems due to the introduction of undesirable materials into soils, water, and air [6]. Such changes in the characteristics of soil, water, and air may have a direct effect on the health of people or other living things. In addition, if inadequate care was taken when human habitation is located near water bodies, problems related to human settlement might pose a threat to rivers, streams, and other water reservoirs. The chemical risks to the Awetu River are hugely associated with human settlement and related activities. Pesticide use for public health and biosecurity, trash disposal, urban runoff, fuel storage, and on-site sanitation and sewage spills (SSO) of a variety of chemicals commonly present in major cities are also a source of water pollution [7].

Increasing pollution and eutrophication of rivers, streams, springs, and other water reservoirs as a consequence of human activity is a concern all over the world, including Africa, particularly Ethiopia [8]. These developing countries lack or do not have stringent measures in place to prevent untreated wastewater from being discharged into rivers, streams, and other bodies of water. Ethiopia's present pollution regulation is ineffective and rarely implemented, making it extremely difficult to protect water bodies and other environmental concerns [9].

Most Ethiopian towns lack waste treatment systems, including Addis Ababa, the capital city of Ethiopia [10]. About 90% of the industrial firms in Addis Ababa discharge their effluents directly into the nearby streams without any form of treatment. In addition, oil pollution on rivers from waste discharge from car wash and garages is a widespread situation in Awetu River. The study conducted on Awetu River revealed that physicochemical parameters like dissolved oxygen are sharply depleted, and biochemical oxygen demand sharply increased downstream.

Besides waste discharged from the aforementioned sources, the Awetu River suffers from diversion of its tributaries, pumping of water for irrigation, deforestation, erosion, and town settlement around the riverside. This has made life difficult for the surrounding fringe dwellers as they depend on the Awetu River to give its water to their cattle to drink. This highly polluted river is a tributary to the Omo River, which pretty much dilutes these pollutants because of its large volume. The Omo River irrigates most of the large-scale farms, fruits, and many more agricultural products [8].

2. Methods and Materials

2.1. Description of the Study Area. The study was conducted in Jimma town having a total area of 220 km^2, which is located, latitude 7°40′N and longitude of 36°50′E [11] as described in Figure 1, at an average altitude of 1750 m above sea level and 346 km southwest of the capital city, Addis Ababa. Due to a lack of systematic land-use classification, most people live in unstructured and scattered residential areas mixed with hotels, bars, restaurants, big shops, milling houses, medium and small clinics, small furniture manufacturing centers, and garages. Private residential houses and small governmental and commercial buildings occupy most of the area.

The central part of the town is highly congested and is characterized by active business transactions. A large number of people live in this central part of the congested area with poor sanitary facilities. The town has a poor sewerage system where the runoff from roads and wastewater from different sources finally end up in the Awetu stream. This brings a big problem for the municipality, which has a limited budget to undertake the collection of solid waste in an integrated manner and cope up with the growing population a significant factor for an increase in solid waste and wastewater.

2.2. Hydrogeology of the Study Area. The study area is located in the southwestern Ethiopia plateau of moderate relief which is situated on a low hill to the north of the wide alluvial plain of the Gilgel Gibe River [12], which inspired by tertiary volcanic rocks, and bedrock is overlain by alluvial sediments which occupied the broad valleys. The thickness of the alluvial sediment beneath the surface ranges from 20 m in the upper part to greater than 200 m in the deeper part of the valleys [13]. Based on the topography, variation in hydraulic properties of the volcanic rocks and alluvial sediment, and their location in the main hydrological basin, the study area is classified into three subbasins as the Kochi, Seto, and Boye subbasins [14]. The Kochi subbasin is drained by the Kochi stream, which joins Awetu River at Boye, and Kito subbasin is drained by the Kito stream and finally joins the Awetu stream at the dado bridge [15]. The prevailing types of rainfall that occur in the study area are orographic and convective, and the annual rainfall and temperature are averagely 1425 mm and 20.9°C, respectively.

2.3. Sampling Macroinvertebrates. Macroinvertebrat**es** were collected using a triangular D-frame Dip-Net (mesh size, 500 μm, sampled area, and 10 m^2) was used to collect benthos by kick sampling method. In this method, the riverbed was disturbed for a distance of about 100 m for 3-5 min and multihabitat approach to dislodge macroinvertebrates attached to any substrate at each sampling point (Gabriels et al., 2010). The collected organisms have been removed, and sieved has been performed in the laboratory using an identification key and a microscope. Benthos sample was conducted three times from each riffle and run sample site, and identification on a family level and macroinvertebrate in species level was done using a compound light microscope and assisted by a standard identification key [16].

2.4. Physicochemical Analysis. The water samples were analyzed for various physical and chemical parameters utilizing American Public Health Association recommended standard methods. The physicochemical parameters such as temperature, pH, electrical conductivity, turbidity, total dissolved solids, BOD_5, COD, acidity, suspended solids, nitrate (NO^{3-}), and orthophosphate were analyzed using the standard analytical methods. The temperature, pH, EC, and turbidity were determined on site using multimeter; turbidity also determined on site using a nephelometric turbidity meter and the standard laboratory method as described by the American Public Health Association for the examination of water samples were employed for the analysis of TDS, DO, COD, and NO^{3-}.

2.5. Macroinvertebrate Diversity Metrics. Benthic microbenthic metrics assess different aspects of community organization and have varying degrees of stimulus sensitivity. As a result, using various metrics is encouraged since an integrated approach ensures a reliable result [17]. In the present study, the total number of taxa (Family level Richness), Percentage Dominant taxa, the Shannon diversity index, and the Simpson index were applied.

2.6. Taxonomic Richness (TR). Taxonomic richness is the number of taxa present in each station, the measure of the community's diversity, and the number of different families found in samples of each site. At the specific radius, diversity has indeed been linked to a variety of environmental pollutants, including increased nutrient richness with improved water quality, habitat diversity, and habitat compatibility [18].

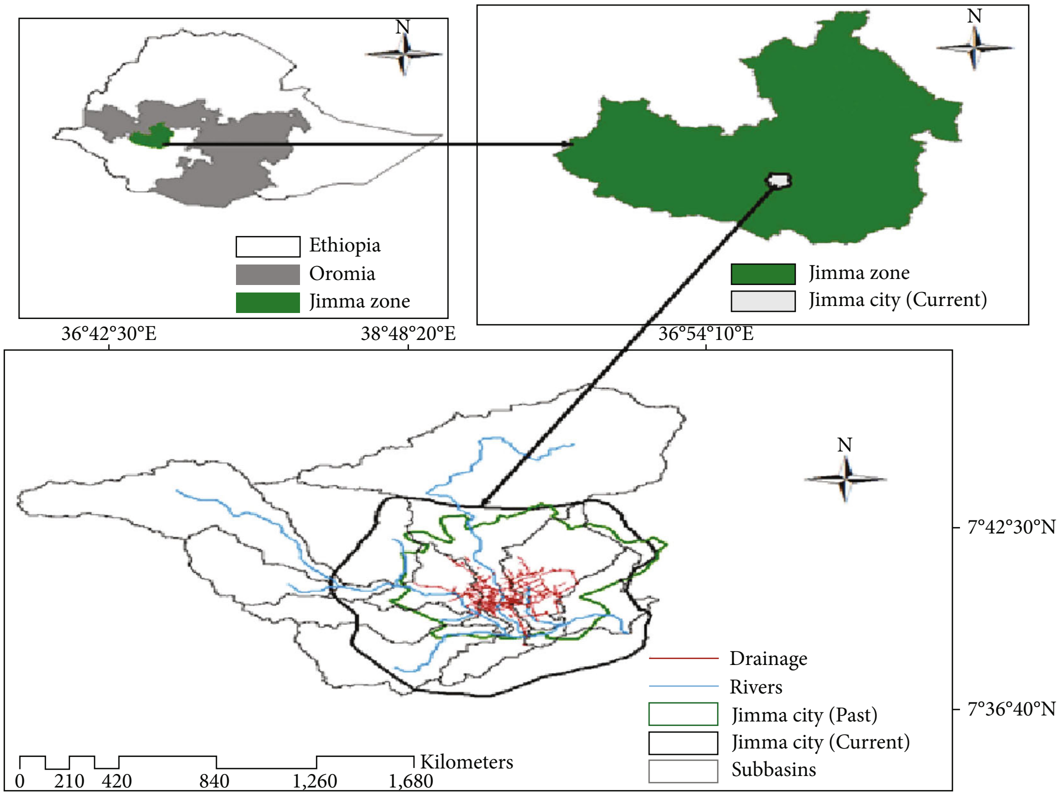

Figure 1: Location of the study area maps.

2.7. Abundance (N). Abundances are the number of individuals from a taxonomic group in each station; relative abundance (Nr) = ratio as a percentage of the number of taxon individuals in a station to the total number of individuals of all species in all stations.

$$\text{Frequency of observation} = (F_1 \times 100)/\text{Ft}. \quad (1)$$

In such, F_1 is the number of stations containing the family, and Ft is the total number of stations studied. Three families were thus distinguished [19], as previously demonstrated, when "very frequent families" ($F \geq 50\%$), "frequent families" ($25\% \leq F \leq 50\%$), and "rare families" ($F \geq 25\%$).

2.8. The Shannon-Wiener Diversity Index (H'). Shannon-Wiener diversity index is a diversity index that incorporates richness and evenness. A high *H*' value indicates a good water quality, and *H*' was calculated as follows:

$$H' = \sum (P_i \ln[P_i], \quad (2)$$

where P_i is the same with pi which means the relative abundance of species in the sample. The Shannon index is expressed in bits. It was determined by the station. Shannon index values obtained were used to assess water quality. *H*' is ranging from zero for a community with a single family, to over 7 for a very diverse community. Less than or nearly one *H* value denotes highly contaminated rivers and streams, one to three moderately contaminated water bodies, and four or more unpolluted water bodies [20].

2.9. Simpson Index (D). The Simpson index $(D) = 1. \sum_{i=1}^{s}($ pi)2 with S standing for the total number of individuals and pi which means the relative abundance. The correlations between physicochemical variables, biotic indices, and macroinvertebrate metrics were determined using Spearman's rank correlation coefficients.

3. Results and Discussions

3.1. Selected Physicochemical Parameters Results. The result of physic chemical parameters of Awetu River identified from the selected 6-sample site was listed in Table 1.

Based on the in situ test results, the temperature of the upstream river is relatively high (S_1) nearest to the coffee processing wastewater directly discharge to this river catchments, even if there is a variation of temperature along the river for all sample sites, the highest temperature is being at the site (S_2) next to S_1, whereas the lowest temperature recorded at the site (S_5). The highest water temperature indicates the pollution status of the water high, which is unfit for use specially, it is too difficult for survival of different microorganism. However, the temperature river water determines the number and types of animals and plants that lives in the waterways. This temperature is a critical water quality and environmental parameters because it governs the kinds and types of aquatic life, regulates the maximum dissolved oxygen concentration of water, and influences the rates of

Table 1: Physicochemical parameters of Awetu river water recorded on each sample site.

P. no	Parameters	Sample sites S1	S2	S3	S4	S5	S6	Average	WHO
1	Temp	25.39	26.08	23.87	21.94	22.12	22.29	23.62	55-60
2	pH	9.35	7.3	7.2	7.4	7.5	7.2	7.658	6.5-8.5
3	EC	52.4	85.6	104.2	121.7	122.1	122.5	101.42	750
4	DO	4.64	5.96	6.76	6.13	4.29	2.89	5.11	5.0-7.0
5	BOD	1018	912	729	690	680	678	784.5	2.0-5.0
6	COD	1320	894	862	804	734	758	895.33	—
7	Turb	6.43	6.14	6.46	14.76	8.75	7.9	8.41	5
8	Alkalin	420	356	465	610	238	290	396.5	120
9	TSS	124	136	156	178	189	210	165.5	—
10	Nitrate	2.92	2.27	2.18	2	1.71	1.97	2.175	45
11	ORTOPHOS.	0.021	0.102	0.07	0.085	0.101	0.106	0.081	0.35

chemical and biological reactions. The total average value of temperature recorded was below the standard guidelines, because those sources of pollutants that emits to this water body have unsteady flow. From on-site measurements, the pH of the sampled water varied from 7.2 to 9.35 with an average value of 7.66. The highest value of pH reading was observed at the upstream and the lowest value at the second sample site (S_2) of water. The pH values of the present investigation were within the standards set for drinking and irrigation purposes, at five sites and above the standard at one site (S_1) since this sampling location is upstream of the coffee processing factory.

Electrical conductivity values recorded varied between 52.8 and 111.7 μS/cm, maximum at the downstream station and minimum at the upstream station. Electrical conductivity of the river at all sites was lower than the permissible limit by WHO for drinking irrigation purposes. Thus, the results indicated that the river receives a low amount of dissolved inorganic substances in ionized form from their surface catchments.

The Dissolved Oxygen (DO) was recorded as maximum value S_3 (6.76 mg/L) and a minimum value of 2.890 mg/L at S_6, but the concentration of Dissolved Oxygen below 5.0 mg/L adversely affected aquatic life. Thus, in this study, DO ranges from 2.89 to 6.76 mg/L, and the minimum value was recorded in Site (S_6), indicating that the studied site was susceptible to pollution due to the nearby market, and a maximum value was recorded in Site (S_3), but since river water is in motion, this DO concentration (self-purification of the water along the course of the river) is increased again at S_4. The Dissolved Oxygen levels are important in the natural self-purification capacity of the river, and a good level of DO in the sampling sites of the river indicated a high reaeration rate and rapid aerobic oxidation of biological substances. However, even if there is variation (maximum and minimum values) of the dissolved oxygen concentration across this river channel, due to emission of pollutants to water sources (minimum value of DO Mg/l) and self-purification station (maximum value of DO mg/l) were recorded, hence, the average values (5.11) were recorded in all sites, which were acceptable in WHO standard.

Biological Oxygen Demand (BOD) is a measure of the amount of oxygen used by biological and chemical processes in a stream of water in five days (BOD5). The maximum value of Biological Oxygen Demand indicates the maximum availability of microorganisms in the that river, and the minimum value of Biological Oxygen Demand shows that the water is already deteriorated by pollutant which reflects only few numbers of benthos survivals. In this study, maximum Biological Oxygen Demand is recorded at upstream (S_1) and minimum BOD at the downstream (S_6); totally, from all sampled sites, its value ranges from 678 to 1018 mg/L, and this value of the river was above the recommended values of WHO standard. This indicates, in the upstream of this river, many microinvertebrates could survive as compared to the middle stream, downstream of the river, and WHO standard guidelines.

The total high concentrations of suspended solids (TSS) cause many problems on stream health, and the total suspended solid can decrease water's natural dissolved oxygen levels which increase water temperature; these means prevent microorganisms living in this water. At the upstream of this river, the minimum TSS was recorded which means increasing the passage of light through water, thereby fasting the photosynthesis by aquatic plants. But in the middle stream and downstream of this river, the TSS increased; due to the increased erosion of bank stream, suspended particles released from dirt and soil can settle out across water (runoff), those enable the risk of wet-weather pollution to be assessed on aquatic organism. In general, from the result of this study, the minimum value of TSS was recorded at the sampling site of S_1, S_2, and S_3, whereas the maximum value of TSS was recorded at S_4, S_5 and S_6, respectively. Nitrates are essential for plants, but in excess amounts, it can cause eutrophication or water quality problems. Mostly nutrients (nitrates and phosphorus) facilitate this eutrophication that dramatically increases in aquatic plant growth and changes in the types of plant and animals that live in the stream. In the upstream of this river, the concentration of nitrate is high as compared to other sites; this is the reason that coffee processing wastewater on the upstream can release to this water without sufficiency on the bank of the river. This coffee processing wastewater influents contains nitrogen, phosphorus, potassium, magnesium, protein, sugar, and lignin, and all those composition are the major pollutants which affects the water quality due to low performance treatment of coffee wastewater influent prior released to disposal area. According to this study, the minimum nitrate concentration is 1.71 mg/L recorded midstream (S_5), and the maximum nitrate concentration is recorded at the upstream station with a value of 2.92 mg/L, and the average value recorded on all sites is (1.175 mg/L) which is below WHO standards.

Phosphates enter waterways from human and animal's wastes, phosphorus rich bedrock, laundry and cleaning wastewater, industrial effluents, and fertilizer runoff. Among those which causes water pollution by this nutrient, the problem of this study area is main fertilizer runoff and cleaning wastewater, which discharges into this river catchment in all direction. Therefore, determinations of orthophosphate are greatly important in water quality surveillances since this compound is regarded as the best indicator of the nutrient's status of natural water. In the same way, this nutrient comes from partially treated and untreated sewage, and runoff from agricultural sites are some of it. Therefore, since these sources of water pollution come from both point and nonpoint sources, starting from upstream, midstream, and downstream in averagely water quality is affected by this contaminant, but due to its cumulative deposition in the midstream, downstream is highly affected as compared to upstream. Chemical Oxygen Demand (COD) is an estimate of oxygen required for the portion of organic matter oxidization and the amount of oxygen consumed by organic matters. Thus, there is a higher value of COD in water samples which indicate that it contains a higher level of oxidizable material; this shows that the water contains low dissolved oxygen concentration, leading to negative environments. In this study, the maximum COD was recorded at upstream and a minimum value at downstream, because at this location, maximum dissolved oxygen concentration level is available due to self-purification of water.

Turbidity is measured by the amount of light that is scattered by the sample, and starting from upstream to downstream, the turbidity value of the sampled water increased as the jar test result indicated. The maximum turbidity was recorded at the (S_4) Site with a value of 14.76 NTU, and the minimum value is 6.14 NTU at S_2, whereas the average turbidity value of the sampled water values obtained for the river was above the permissible limit set by WHO for drinking. This was cause by overburden of residue and other total suspended solid, which directly or indirectly affects water quality and increased turbidity of the water.

Alkalinity is a measure of water capacity to neutralize acids and is important during softening, and in this study, the alkalinity ranged between 238 and 610 mg/L which indicates that alkalinity at all sites was above the desirable limit of the standard guideline. The high values of alkalinity may also be due to an increase in free carbon dioxide in the river, which ultimately increases the alkalinity.

3.2. Macroinvertebrate Results and Discussion

3.2.1. Macroinvertebrate Order. For all site sampled site, the following metrics were calculated for the macroinvertebrate studies: (i) taxonomic richness (i.e., number of taxa), (ii) abundance (i.e., number of individuals per site), (iii) Shannon-Wiener's diversity index (H') (Nurhafizah-Azwa and Ahmad, 2018), and (iv) the Simpson diversity index (1-D) (Micha, 2014). The water quality assessment for a range of bio index values was presented in Table 2.

3.2.2. Taxa Richness. A total of 1413 individual macroinvertebrates which belong to eight orders and 48 species were collected for this study area, and the most abundant orders were Odonatan 383 (27.1%), number of species 9; Tricopetra 246 (17.4%), number of species 8; Dipteral 234 (16.6%), number of species 8. The slenderest orders were Coleptera, 148 (10.5%), with species number 6; Plecoptera, 69 (4.9%), number of species 3; Hirudinea, which is 50 (3.5%), number of species 1, but among the orders, Hemiptera and Ephemeroptera are moderately abundant taxa with 157 (11.1%), number of species 7 and 126 (8.9%), number of species 6, respectively. The lowest taxa richness value might be attributed to wastewater discharged from dishwashing liquid, open bathing, municipal waste disposal, and organic enrichment through surface runoff from urban land use. The highest taxa richness is at S_5 and S_6; the probable reason might be explained due to the sites' good physical habitat quality and water quality as well as good ecological integrity.

As indicated in Table 3, among 1413 individual macroinvertebrates, 383 families of Odonata, 118 families are collected from (S_1), which is the highest percentage, whereas the moderate families are collected from sampling S_2, S_3, and S_4, but on S_5 and S_6, the list number of this families is collected. Next to this families, the most abundant order is Tricoptera, from the total 246 samples, about 70 and 64 families are collected from S_1 and S_2, but the least collected number of this families are at the S_4 and S_5. Odonata, Coleoptera, Hemiptera, Trichoptera, Plecoptera, and Ephemeroptera families were highly accumulated on site (S_1) (in the upstream), and a smaller number of families were on site (S_6) (downstream from the total number of their families). Nevertheless, less numbers of these orders were recorded high abundant of families (Hirudinea and Dipteral) at the downstream of the river. Based on their sampled species, number of each site of percentage composition of invertebrate's taxa and accumulation curve with 95% confidence interval was described in Figure 2.

3.3. Macroinvertebrate Indices

3.3.1. Abundance. The number of individual macroinvertebrates per benthic site ranged from 0 to 338, and the changes of dominant species at the 6 sites expressed clearly the habitat characteristics of the Awetu River and its tributaries.

3.3.2. Bioindex Analysis. In the present study, to indices, Shannon's diversity index and Simpson's diversity index were selected for the calculation of taxon.

Table 2: Ranking of bio index values of benthic macroinvertebrates ((Restello, 2010), (Edia, 2009)).

No	H'	1-D	Ranking
1	>3.25	>0.90	Very light pollution
2	2.20-3.25	0.65-0.90	Light pollution
3	1.40-2.20	0.40-0.65	Low moderate pollution
4	0.80-1.40	0.25-0.40	High moderate pollution
5	0.10-0.80	0.10-0.25	Heavy pollution
6	<0.10	<0.10	Very heavy pollution

Notes: H': Shannon-Wiener diversity index; D: Simpson dominance index.

Table 3: Order of macroinvertebrate load collected from selected site of Awetu River.

Order	Sample site							Average	%
	S_1	S_2	S_3	S_4	S_5	S_6	Sum		
Odonata	118	76	63	51	33	42	383	63.8	27.1
Himeptera	43	35	27	18	13	21	157	26.2	11.1
Coleptera	52	48	31	9	7	1	148	24.7	10.5
Tricoptera	70	64	49	26	19	18	246	41.0	17.4
Dipteral	0	11	17	28	61	117	234	39.0	16.6
Ephemeroptera	54	32	13	11	7	9	126	21.0	8.9
Plecoptera	29	18	12	7	3	0	69	11.5	4.9
Hirudinea	4	5	7	7	9	18	50	8.3	3.5
Total	370	289	219	157	152	226	1413	235.5	100

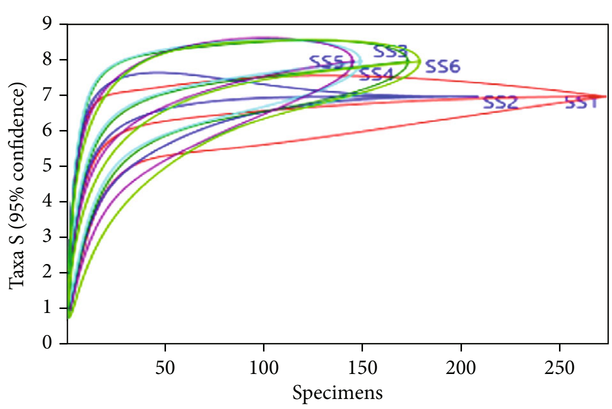

Figure 2: Taxa accumulation curve estimated with 95% confidence interval.

3.3.3. The Shannon Diversity Index. The Shannon diversity index of macroinvertebrate communities was significantly lower at sampling sites of Agricultural and veterinary medicines campus beyond around coffee processing factory (S_1 and S_2) (2.076 and 2.227), respectively, where macroinvertebrate was found with a range from 2.076-2.701 at all sites of the river. The Shannon diversity index value is higher in midstream and downstream sites relative to the selected site of the river, namely, S_3, S_4, S_5, and S_6 (2.465, 2.701, 2.570, and 2.416). Turkmen and Kazanci, 2010, most of the value measured using the Shannon diversity index ranges from 1.5 to 4.5; above 3.0 value indicates that the habitat structure is stable and balanced, but less than 1 value indicates the presence of pollution and degradation of the habitat structure. Based on these criteria, all sampling sites of study area are below 3 values for all sites as indicated in Table 4 which means the presence of a light pollution level and degradation of habitat structure in the studied area exists. Figure 3 shows the Shannon index value highest on sample site S_4, at midstream with the value of 3 on site S_1, S_2, S_3, S_5, and $S_{6;}$ the value of Shannon diversity indices increases.

3.3.4. The Simpson Diversity Index. The Simpson diversity index of macroinvertebrate communities was also significantly lower at all sampling sites. From the results of macroinvertebrate data collected from the Awetu river sample site, the Simpson diversity index was found ranging from 0.879-0.922. Therefore according to Smith and Wilson, 1996, the Simpson diversity index has values ranging from zero to one, and the smallest evenness is zero, while the highest evenness is one. Based on this fact, all sites have fallen to nearly zero and indicated the presence of light pollution in all sites of the Awetu River from upstream to downstream. Based on the rank criteria of the Simpson diversity indices, all sites selected for the test fell in light pollution level, and this indicates that the river was deteriorated by anthropogenic activities, including open defecation, linkage of toilets from nearby dwellers, washing, and other hotel and restaurant influents.

3.4. Multivariate Analysis

3.4.1. Relationship between Macroinvertebrates and Physicochemical Parameters. The study was tested for redundancy among metrics using Spearman rank-order

Table 4: Results of bioindices of Awetu River for all sites.

	Sample site					
	S1	S2	S3	S4	S5	S6
Taxa_S	11	16	23	32	24	28
Individuals	304	267	188	142	139	153
Dominance_D	0.138	0.128	0.107	0.084	0.109	0.139
Simpson_1-D	0.880	0.888	0.905	0.922	0.903	0.879
Shannon_H	2.076	2.227	2.465	2.701	2.570	2.416
Evenness_e^H/S	0.680	0.497	0.501	0.604	0.542	0.475

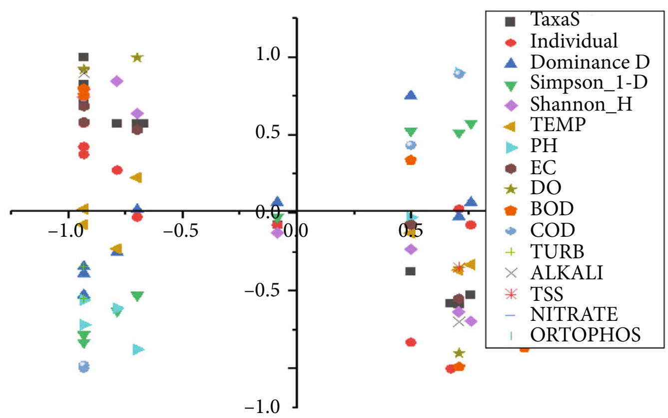

Figure 3: Canonical correspondence analysis macroinvertebrates and physiochemical of the study area.

correlation analysis, and if the Spearman correlation coefficient was greater than 0.75 and the p value was much less than 0.05, metrics were deemed redundant [1].

3.4.2. Composition and Distribution of Macroinvertebrates. A total of 1413 individual macroinvertebrate which belongs to eight (8) orders and 48 species were collected from all sampled sites, and the most abundant orders were Odonata 383 (27.1%), tricopetra 246 (17.4%) and Diptera 234 (16.6%). The most dominant orders were Plecoptera, which is 69 (4.9%) and Hirudinea, which is 50(3.5%). However, among the orders, Hemiptera and Ephemeroptera are moderately abundant taxa with 157 (11.1%) and 126 (8.9%), respectively. The observed taxonomic abundance is very low compared with the one reported by [5] at the Alibori River 39,718 individuals; however, it is greater than the upper Oueme River, whereby 1057 organisms were identified [21]. Canonical correspondence analysis (CCA) was performed to correlate with physicochemical parameters and macroinvertebrates indices. The triplot of CCA indicates 86.54% of the variables were controlled by the system of axis1 pH, DO, BOD, COD, and TSS, and Nitrate was negatively correlated with dominance. On the other hand, Simpson and Shannon's diversity index was strongly correlated with EC, turbidity, alkali, and orthophosphate on axis 2; Leeches, Triplicate, Canidae, baelidae, syrphidae, hydropsiychidae, and Ephemeridae were positively correlated with EC, turbidity, alkali, and COD. Aeshenidae, Pycentropodea, Chronomide, Dytiscidae, and Elmidae are strongly and negatively associated with axis1.Whereas Gonophidae and belostomalidae have a strong positive correlation. Leptophlebiidae, Hydrophilidae, Nemouridae, Dytiscidae, bellulidae and TSS, DO, pH, Temp, and nitrate are negatively associated with axis2. Additionally, Gonophidae and belolluli-dae are negatively associated with TSS, DO, pH, Temp, and nitrate with axis 2. The ecological status of Awetu A using physicochemical parameters, biotic indices/metrics, and multivariate analyses indicated ecological deterioration with lightly polluted.

3.4.3. Ecological Quality of Study River. The calculated Shannon-Weaver index is less than 3, indicating that the water of the Awetu River have been lightly polluted, which reflect to a lower biological diversity in the studied stations. The values of the Shannon diversity index recorded are lower than the values obtained by [22] in the Nga streams in Cameroon and by [23] in the So River in southern Benin. However, the low values are consistent with the results of the river reported by [24] on the Ikpoba River in Nigeria. The maximum values of Simpson's index are 0.922, and this shows that macroinvertebrates are more or less distributed at some stations of the study area. Consequently, the same sampling sites indices have zero levels at certain location, which implies that there is still some biodiversity and some organisms which are poorly organized and dominated by a single species.

4. Conclusions

Water is the critical treasured resource for all ecosystem, especially potable water is mandatory for both health of aquatic and human life. Therefore, the study was concerned to assess the pollution status of Awetu River by using integrated physicochemical and macroinvertebrate in order to determine its water quality standards whether or not it fits the water quality guidelines. Accordingly, among the physicochemical water quality investigated, only pH and DO averagely meet the standard criteria of WHO guidelines. Most of these parameters were above (EC, BOD5, Turbidity, and Alkalinity) standard, whereas Orthophosphates, Nitrate, and Temperature were averagely below the standard levels. Indeed, the limited or unlimited values of physicochemical (BOD, COD, EC, TSS, nitrate, and orthophosphates) are major responsible for deterioration of the river quality caused by light pollution. In addition, the deteriorated water quality, results indicated that the number and types of macroinvertebrates can survive into this water bodies and this causes for the variation of order; families and their species from each sampled sites and hence the study used their average for each site of upstream, midstream, and downstream.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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