# TECHNICAL REPORT ON

# LATA NA CATCHMENT MANAGEMENT PLAN

## DEVELOPED UNDER

## AGRO-CLIMATIC RESILIENCE IN SEMI-ARID LANDSCAPES

## (ACRESAL) PROJECT

## (WORLD BANK ASSISTED)

## BY

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**Executive summary**
The Lata na Catchment Management Plan (CMP) is a Catchment Management Plan that is funded by the World Bank and developed under the Agro-Climatic Resilience in Semi-Arid Landscapes (ACReSAL) Project. The Management plan aims at improving sustainable landscape management practices in the Lata na catchment area which includes Patigi, Lafiagi and Lata towns all within the Edu Local Government of Kwara State, Nigeria. The improvement was targeted towards addressing key environmental and socio-economic challenges by providing a comprehensive framework for integrated catchment management to ensure long-term sustainability and resilience against climate change impacts.

## Background

The spotlight of ACReSAL Project is to develop micro-catchment management plans which will address agro-climatic challenges in Kwara state. The plans proffer possible solutions on how to get potable water from surface and underground sources for domestic and agricultural purposes, enhance soil health, and getting the people of the state to be socio-economic buoyant. The Lata na catchment, drained by tributaries of Rivers Oro, Satu, Nyemi, Rahi and Egwa play a significant role in irrigation of the neighboring farm lands.

## Environmental Assessment

- **Location, Extent and Accessibility of the Catchment**

  The Lata na catchment is located within Edu Local Government of Kwara State, Nigeria. The catchment is bounded by latitudes $8^0$35' to $8^0$45' and longitudes $5^0$20' to $5^0$30' covering an approximate area of 342 $km^2$ (Fig. 1). Among the notable settlements in the catchment include Patigi, Lafiagi and Lata. The catchment is accessible by motorable roads and footpaths linking villages in the area.

- **Land Use and Land Cover Dynamics**: The primary land use of Lata na catchment is agriculture with about 60% of the land occupied by farm lands mainly for rice production, 30% occupied by livestock rearing, and the remaining 10% is occupied by vegetation cover (Fig. 1).

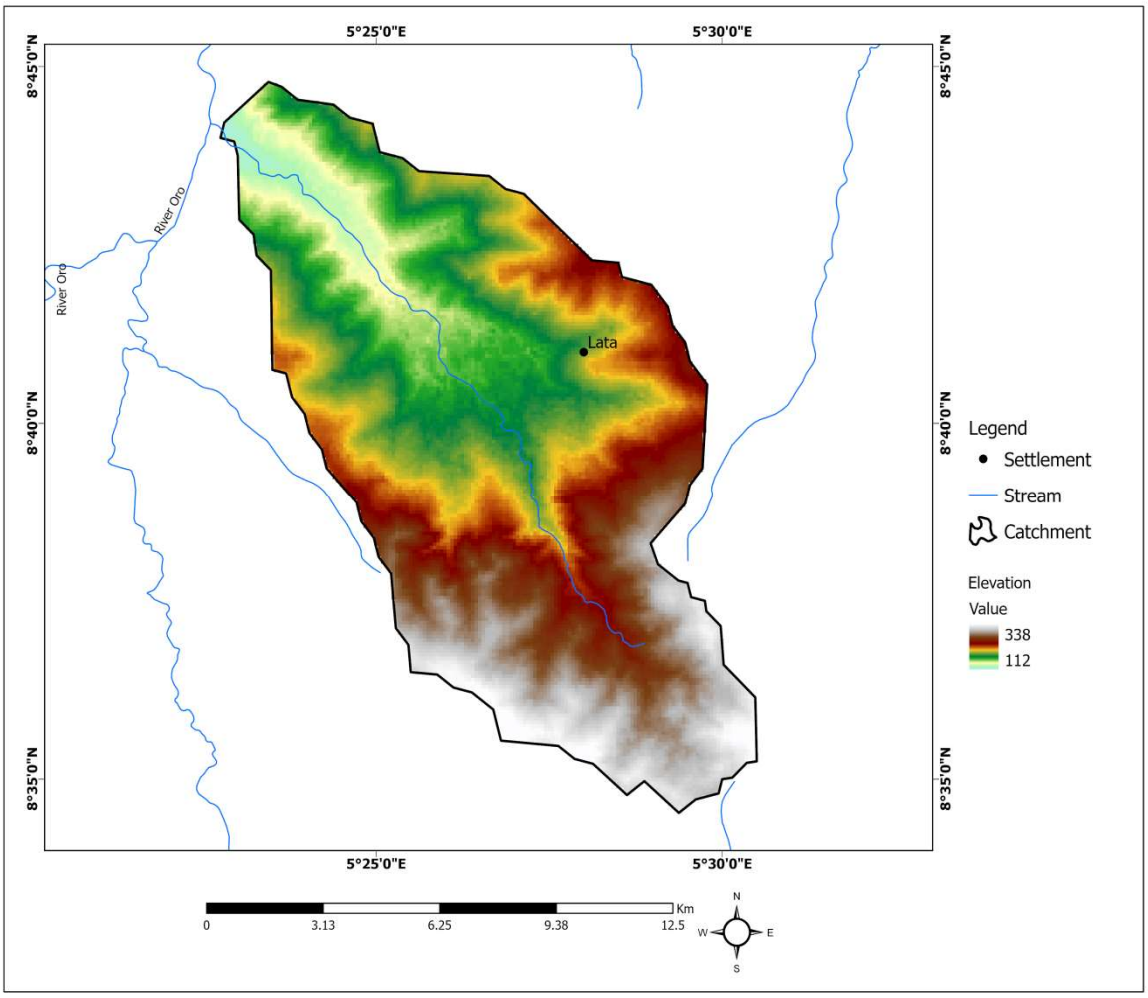



Figure 1: Location map of Lata na Catchment

- **Geology, Hydrology and Hydrogeology of the Catchment**

  Geology

The Lata na catchment is underlain by Sedimentary rocks which include sandstones that are conglomeratic, pebbly and cobly in nature, clay stones and siltstones. The catchment area belongs to the Northern Bida Basin where Adeleye, (1973) stated that the basal bed in the Basin is succeeded by a relatively thin but laterally very persistent, fossiliferous oolitic and pisolitic ironstone of Sakpe Ironstone formation and that the succeeding Enagi Siltstone formation contains a leave impression. The Upper Cretaceous sequences in the Basin have also been investigated by (Olaniyan and Olobaniyi, 1996). They examined the pebble morphology, grain size distribution, facies distribution and suggested a braided ephemeral streams for the fining

upward sequences of claystones-sandstones facies. The NW-SE trending Bida Basin is an interesting representation of cretaceous geology in Nigeria particularly in the Campanian-Maastritchtian time

Hydrology

The hydrology of the catchment is made up of rivers, streams and lakes available in the catchment. Among the notable rivers are Rivers Oro, Satu, Nyemi, Rahi and Egwa. Nigeria is made up of eight hydrological areas namely Niger North, Niger Central, Niger South, Upper Benue, Lower Benue, Western Littoral, Eastern Littoral and Chad Basin. Kwara State where Lata na catchment is falls within the Niger central Hydrological area (Fig.2).

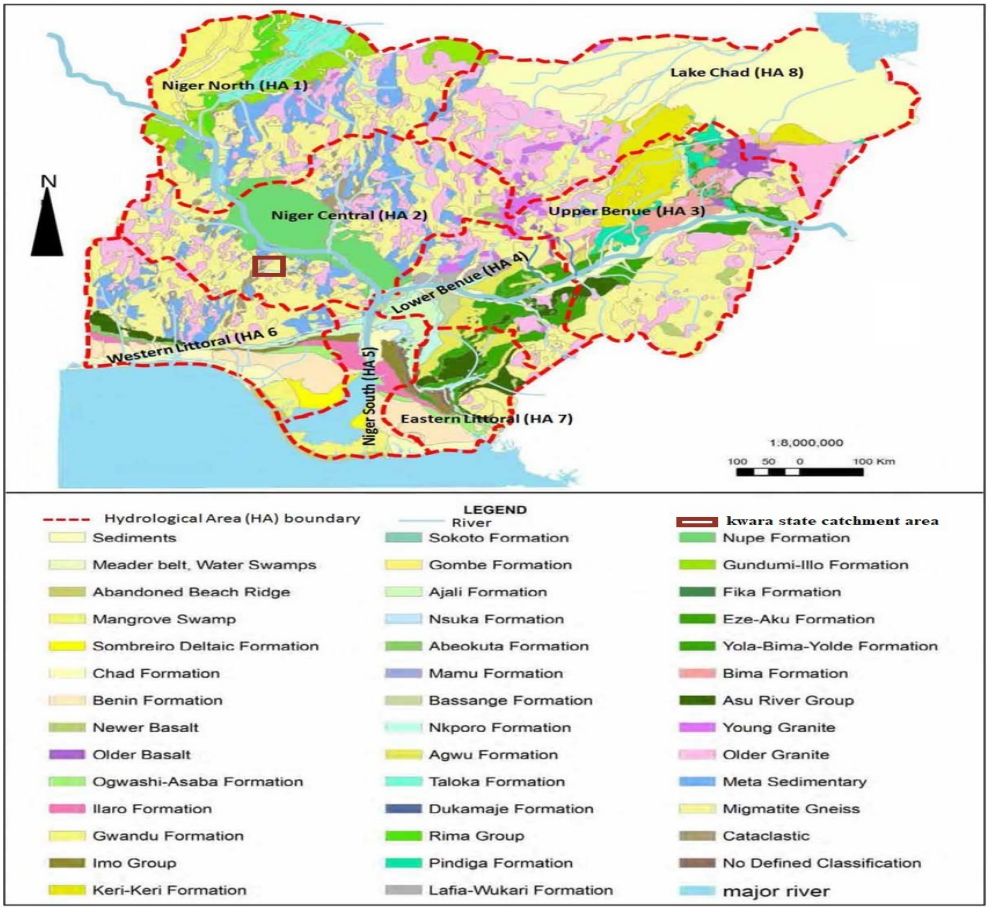



Figure 2: Map of Nigeria showing the location of Kwara state within the Niger central Hydrological area

Hydrogeology

Hydrogeology can be described as the scientific study of groundwater with emphasis on the

geology and its occurrence, movement and characteristics of groundwater. The Bida Basin where the catchment fall in comprises of porous geological formations that can produce appreciable groundwater.

The groundwater level flow direction of the catchment shows that the groundwater in the catchment flows from high water level elevation (high groundwater potential) to low water level elevation (low groundwater potential). The flow direction is indicated by the arrows drawn perpendicularly to the groundwater contours (Fig. 3). The groundwater contour elevation map was produced by subtracting the groundwater level values in the catchment from their respective altitudes values and then joining points of equal elevation together.

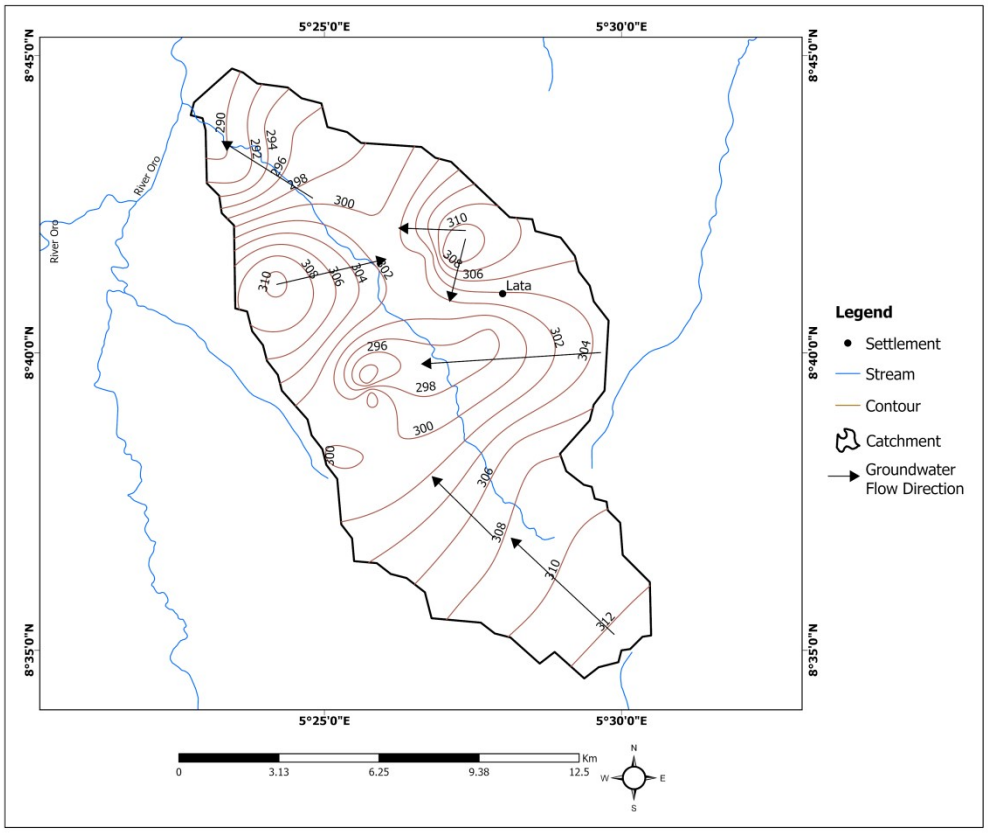



Figure 3: Lata na catchment map showing the groundwater flow direction

- **Water Resources Availability and Quality**: Water resources in Lata na catchment area comprise both surface and groundwater. Most of the rural communities in the catchment area depend on hand-dug wells for their water supply with some governmental and charitable drilled boreholes. Most of the hand-dug wells in the catchment tapped a

weathered overburden aquifer making the wells productive. Water quality analyses revealed that the physical, chemical and biological parameters analysed for the water's quality assessment fall mostly below the acceptable and permissible limits of the World Health Organization Standard (WHO) and Nigeria Standards for Drinking Water Quality (NSDWQ)

- **Water sampling and Determination of In-situ Field Parameters**

Ten water samples from both surface and groundwater sources were collected in the Lata na catchment using 0.5 litre polyethylene plastic bottles (Fig.4).The bottles were thoroughly rinsed two to three times with the water to be collected with. Two water samples were collected from each collection point; one for cation determination and the other for anion determination. The water samples for cation determination were acidified with two to three drops of concentrated nitric acid ($HNO_3$) in order to reduce the adsorption of ions in solution and to reduce the bonds between the water and the container. (Fig. 5a, 5b and 5c)

Some parameters such as pH, Electrical Conductivity (EC), turbidity (NTU) and temperature were measured in-situ because their values may change soon after leaving the point of collection. The samples were preserved in a refrigerator and taken to the laboratories for analyses.

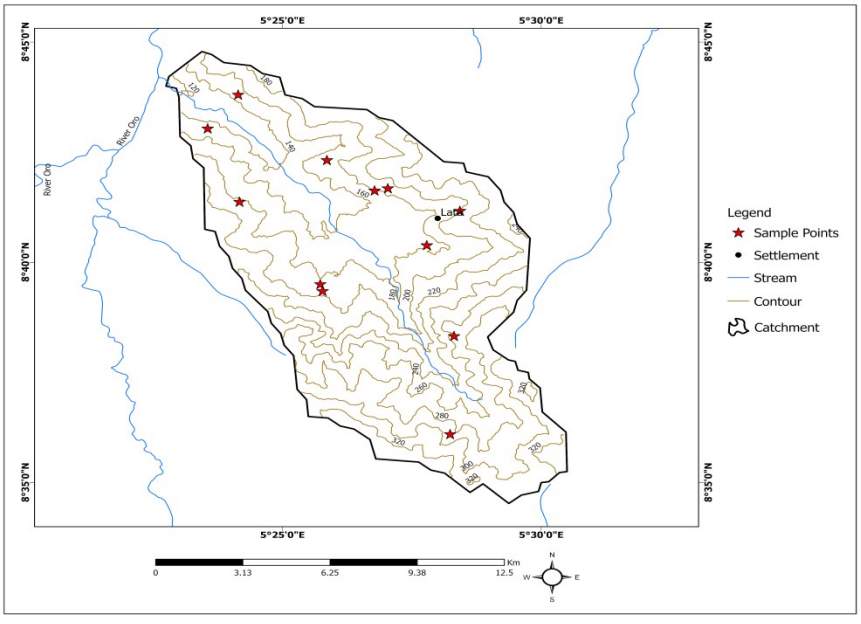



Figure 4: Lata na catchment map showing the water sampling points



Figure 5a: Groundwater sample collection point and measurement of groundwater level



Figure 5b: Surface water collection point



Figure 5c showing acidification of water samples with 2 to 3 drops of $HNO_3$

**Physical and Chemical Quality of Water in Lata na Catchment for Drinking Purpose**

The results of the analyses for water quality assessment in the catchment are presented in Tables 1 and 2 and the average values obtained are compared with the World Health Organization (WHO) standard and the Nigerian standards for drinking water quality (NSDWQ) (Table 3). The average values of the physical parameters analysed were all below the acceptable and permissible limits of the World Health Organization standard and the Nigeria Standard for Drinking Water Quality (NSDWQ) except for temperature and Turbidity whose values were above the acceptable limits of WHO and NSDWQ standards but are below their permissible limits (Table 3). Also, the average concentrations of the major cations and anions analysed were all below the acceptable limits and far below the permissible limits of WHO and NSDWQ standards except for bicarbonate whose value is higher than the WHO and NSDWQ acceptable and permissible limits (Table 3). This high concentration of bicarbonate can lead to reduction in the nutrients available for plants in the catchment and can cause a slightly soapy taste in drinking water and causing stomach upset or bloating. The average concentrations of the toxic elements analysed were below the acceptable and permissible limits of WHO and NSDWQ

standard except for Manganese whose value is above the acceptable limits and slightly (negligible (0.909) above the permissible limits and Chromium whose value is above the acceptable limit but below the permissible limits (Table 3).

From these analyses, it has been revealed that the surface and Groundwater sources in the catchment are physically and chemically good but an acid injection method has to be adopted by adding sulphuric acid to the water to lower its PH thereby neutralizing the bicarbonate and reducing its concentration.

Table1: Result of Physical Quality Analysis for Surface and Groundwater Samples in Lata na Catchment

| **Sample Code** | **Coordinates** | **Locations** | **Water Source** | **PH** | **Temperature($^0$C)** | **Turbidity** (NTU) | **Electrical Conductivity** (μs/cm) | **TDS (mg/l)** | **TH (mg/l)** |
|---|---|---|---|---|---|---|---|---|---|
| LTN 1 | N $08^0$43.18'<br>E $05^0$45.82' | Alh. Ibrahim Mosque | Hand-dug well | 7.2 | $32.8^0$ | 1647 | 0.74 | 0.518 | 21.787 |
| LTN 2 | N $08^0$43.914'<br>E $05^0$45.245' | Ndabishi well | Hand-dug well | 6.9 | $31.4^0$c | 3219 | 1.44 | 1.008 | 26.729 |
| LTN 3 | N $08^0$43.940'<br>E $05^0$45.015' | Nyemi River | River | 7.9 | $33.1^0$c | 108 | 0.04 | 0.028 | 8.729 |
| LTN 4 | N $8^0$40.396'<br>E $5^0$27.792' | Satu Stream | River | 8.1 | $27.8^0$c | 108 | 0.04 | 0.028 | 6.760 |
| LTN 5 | N$08^0$ 41.174'<br>E $005^0$ 28.437' | River Cutter | River | 6.6 | $27.8^0$c | 78 | 0.03 | 0.021 | 7.108 |
| LTN 6 | N$08^0$ 46.042'<br>E$005^0$ 22.765' | River Rahi | River | 8.2 | $27.9^0$c | 222 | 0.09 | 0.063 | 7.021 |
| LTN 7 | N$08^0$ 52.057'<br>E$005^0$ 23.009' | Baka River | River | 7.7 | $33.4^0$c | 108 | 0.04 | 0.028 | 4.339 |
| LTN 8 | N$08^0$ 51.706'<br>E$005^0$25.661' | Egwa River | River | 7.8 | $34.9^0$c | 240 | 0.1 | 0.07 | 6.321 |
| LTN 9 | NO$8^0$ 51.083'<br>E$005^0$ 25.041' | Emisakiwa well | Hand-dug well | 6.9 | $32.6^0$c | 882 | 0.4 | 0.28 | 5.444 |
| LTN 10 | N$08^0$51.049'<br>E$005^0$ 25.175' | Nda Ewobokun well | Hand-dug well | 7.0 | $30.8^0$c | 1662 | 0.78 | 0.546 | 6.101 |
| **AVERAGES** | | | | **7.43** | **32.8** | **827.4** | **0.37** | **0.259** | **10.034** |

**Note: LTN in the sample code stands for 'Lata na'**

Table2: Result of Chemical Quality Analysis for Surface and Groundwater Samples in Lata na Catchment

| Sample Code | Coordinates | Na | K | Ca | Mg | Fe | Pb | Zn | Cr | Mn | Cu | $SO_4$ | $NO_3$ | Cl | $CO_3$ | $HCO_3$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LTN 1 | N $08^0$43.18' E $05^0$45.82' | 2.157 | 0.956 | 1.248 | 4.533 | 0.015 | ND | 0.07 | 0.001 | 1.088 | 0.001 | 0.187 | 0.31 | 54 | 148 | 100.04 |
| LTN 2 | N $08^0$43.914' E $05^0$45.245' | 2.349 | 0.513 | 1.778 | 5.415 | 0.175 | ND | 0.085 | 0.001 | 1.113 | 0.034 | 0.219 | 0.449 | 105.5 | 44 | 378.2 |
| LTN 3 | N $08^0$43.940' E $05^0$45.015' | 1.731 | 0.106 | 0.178 | 2.012 | 0.001 | ND | 0.031 | 0.001 | 1.11 | 0.001 | 0.223 | 0.388 | 14 | 436 | 409.92 |
| LTN 4 | N $8^0$40.396' E $5^0$27.792' | 1.491 | 0.065 | 0.126 | 1.565 | 0.001 | ND | 0.034 | 0.005 | 1.076 | 0.001 | 0.203 | 0.155 | 14 | 112 | 302.56 |
| LTN 5 | N$08^0$ 41.174' E $005^0$ 28.437' | 1.567 | 0.074 | 0.192 | 1.61 | 0.001 | ND | 0.035 | 0.101 | 1.067 | 0.059 | 0.201 | 0.155 | 15.5 | 160 | 470.92 |
| LTN 6 | N$08^0$ 46.042' E$005^0$ 22.765' | 1.429 | 0.089 | 0.053 | 1.673 | 0.002 | ND | 0.07 | 0.069 | 1.046 | 0.03 | 0.203 | 0.31 | 15.5 | 108 | 785.68 |
| LTN 7 | N$08^0$ 52.057' E$005^0$ 23.009' | 1.415 | 0.135 | 0.143 | 0.967 | 0.001 | ND | 0.051 | 0.076 | 1.065 | 0.001 | 0.205 | 0.233 | 18 | 60 | 90 |
| LTN 8 | N$08^0$ 51.706',' E$005^0$25.661' | 1.315 | 0.116 | 0.244 | 1.387 | 0.001 | ND | 0.046 | 0.176 | 1.107 | 0.001 | 0.199 | 0.233 | 10.5 | 64 | 275.2 |
| LTN 9 | NO$8^0$ 51.083' E$005^0$ 25.041' | 1.695 | 0.341 | 0.13 | 1.243 | 0.001 | ND | 0.053 | 0.062 | 1.132 | 0.001 | 0.2 | 0.233 | 50 | 64 | 488.6 |
| LTN 10 | N$08^0$51.049' E$005^0$ 25.175' | 1.607 | 0.482 | 0.39 | 1.245 | 0.076 | ND | 0.09 | 0.135 | 1.11 | 0.001 | 0.215 | 0.31 | 55.5 | 72 | 691.65 |
| **AVERAGES** | | **1.68** | **0.29** | **0.448** | **2.17** | **0.03** | **ND** | **0.06** | **0.06** | **1.09** | **0.013** | **0.21** | **0.28** | **35.3** | **127** | **399.3** |

Table 3: Comparison of the obtained results for physical and chemical parameters of Surface and Groundwater samples in Lata na catchment with the World Health Organization (WHO) standard and Nigeria Standard for Drinking Water Quality (NSDWQ) (2024)

| S/N | Physical and chemical Parameters | Average concentrations obtained | WHO Acceptable limits | WHO permissible limits | NSDWQ |
|---|---|---|---|---|---|
| 1 | PH | 7.43 | 6.5-8.5 | 9.2 | 6.5-8.5 |
| 2 | Temperature (0 c) | $32.8^0$C | $27^0$C | | |
| 3 | Turbidity (NTU) | 827.4 | 5 | 1000 | 5 |
| 4 | Electrical conductivity (µs/cm) | 0.37 | 1400 | | 1000 |
| 5 | Total Dissolved Solid (mg/l) | 0.259 | 500 | 1500 | 500 |
| 6 | Total Hardness (mg/l) | 10.034 | 100 | 500 | 150 |
| 7 | Calcium ion (mg/l) | 0.448 | 75 | 200 | 75 |
| 8 | Sodium ion (mg/l) | 1.676 | 50 | 200 | |
| 9 | Potassium ion (mg/l) | 0.288 | 20 | 200 | 20 |
| 10 | Magnesium ion (mg/l) | 2.165 | 50 | 150 | 0.2 |
| 11 | Iron ion (mg/l) | 0.027 | 0.05 | 0.35 | 0.05 |
| 12 | Manganese ion (mg/l) | 1.091 | 0.1 | 1 | 0.1 |
| 13 | Chromium (mg/l) | 0.063 | 0.0.5 | 1.5 | 0.05 |
| 14 | Zinc ion (mg/l) | 0.057 | 1.5 | 3 | 1.5 |
| 15 | Lead ion (mg/l) | ND | 0.01 | 3 | 0.01 |
| 16 | Copper (mg/l) | 0.013 | 0.05 | 1.5 | 0.003 |
| 17 | Carbonate (mg/l) | 126.8 | - | - | - |
| 18 | Bicarbonate (mg/l) | 399.28 | 125 | 350 | 125 |
| 19 | Chloride (mg/l) | 35.3 | 250 | 600 | 100 |
| 20 | Sulphate (mg/l) | 0.206 | 200 | 400 | 100 |
| 21 | Nitrate (mg/l) | 0.278 | 50 | 500 | 10 |

- **Biological Quality of water in Lata na Catchment**

The biological quality assessment for water in the catchment involved the microbial analyses of the water samples for Total colliform count and Escherichia coli (E-coli). The Total colliform count gives the total amount of microbes available in the water while the presence of Escherichia colli indicates evidence of faecal pollution in the water, although absence of this organism does not indicate safe water. The result of the analysis is presented in Table 4. From the table, the average concentrations of the total colliform count and E- coli are 3.00 CFU/ml and 0.45 CFU/ml respectively. The average values of the concentrations were far below the acceptable and permissible limits of the WHO standard which are <10CFU/ml and 10000 CFU/ml respectively; indicating that the water in the catchment is biologically of good quality.

Table 4: Result of Microbial Analysis for surface and Groundwater samples of Lata na Catchment

| **Sample Code** | **Coordinates** | Total colliform count (CFU/ml) D.F x$10^3$ | *E. coli* (CFU/ml) D.F x$10^3$ |
|---|---|---|---|
| LTN 1 | N $08^0$43.18'<br>E $05^0$45.82' | 5.5 | 0 |
| LTN 2 | N $08^0$43.914'<br>E $05^0$45.245' | 9 | 2.5 |
| LTN 3 | N $08^0$43.940'<br>E $05^0$45.015' | 4 | 0 |
| LTN 4 | N $8^0$40.396'<br>E $5^0$27.792' | 0 | 0 |
| LTN 5 | N$08^0$ 41.174'<br>E $005^0$ 28.437' | 0 | 0 |
| LTN 6 | N$08^0$ 46.042'<br>E$005^0$ 22.765' | 0 | 0 |
| LTN 7 | N$08^0$ 52.057'<br>E$005^0$ 23.009' | 0 | 0 |
| LTN 8 | N$08^0$ 51.706',<br>E$005^0$25.661' | 4 | 0 |
| LTN 9 | NO$8^0$ 51.083'<br>E$005^0$ 25.041' | 0 | 0 |
| LTN 10 | N$08^0$51.049'<br>E$005^0$ 25.175' | 7.5 | 2 |
| **AVERAGES** | **2.533** | **3.00** | **0.45** |

- **Quality of the water sources in the catchment for Irrigation purposes**

The suitability and Quality of both surface and groundwater samples in Lata na catchment would be discussed under the following headings:

**a. Salinity Hazard**

Salinity Hazard of water for irrigation is low, medium, high or very high according to electro-conductivity of water. For irrigation purpose, the water samples in the catchment area are of low salinity hazard; indicating that the water is excellent for irrigation. The low salinity hazard of the surface and groundwater is due to the values of electrical conductivity of the water samples which range from 0.03µS/cm to 1.44µS/cm (Table 1) making the water to fall within the low salinity hazard class according to Wilcox (1948) and Mohammad *et al*., 2019**)** classification (Table 5).

Table 5: Suitability of water for irrigation in respect of Salinity Hazard (After Wilcox, 1948 and Mohammad *et al*., 2019)

| Salinity Hazard | Range of Electrical conductivity (µS/cm) |
|---|---|
| Low | Less than 250 |
| Medium | 250 to 750 |
| High | 750 to 2250 |
| Very high | Greater than 2250 |

**b. Sodium Hazard**

The sodium Hazard concentration in the water of the catchment is calculated using Sodium Adsorption Ratio (SAR) formular. The SAR was obtained from the following expression:

Sodium Adsorption Ratio: $Na^{+}/\sqrt{(Mg^{2+} + Ca^{2+})/2}$

Where: Na, Mg and Ca are all calculated in milli-equivalents per litre

The calculated SAR for the water samples in the catchment is shown in Table 6

Table 6: Calculated SAR for the water samples in the Catchment

| Sample Code | $Na^{+}$(meq/l) | $Ca^{2+}$(meq/l) | $Mg^{2+}$(meq/l) | $\sqrt{(Mg^{2+} + Ca^{2+})/2}$ | $Na^{+}/\sqrt{(Mg^{2+} + Ca^{2+})/2}$ |
|---|---|---|---|---|---|
| LTN 1 | 0.094 | 0.062 | 0.373 | 0.466 | 0.202 |
| LTN 2 | 0.102 | 0.089 | 0.446 | 0.517 | 0.197 |
| LTN 3 | 0.075 | 0.009 | 0.166 | 0.296 | 0.253 |
| LTN 4 | 0.065 | 0.006 | 0.129 | 0.259 | 0.251 |
| LTN 5 | 0.068 | 0.009 | 0.132 | 0.266 | 0.256 |
| LTN 6 | 0.062 | 0.003 | 0.138 | 0.266 | 0.233 |
| LTN 7 | 0.062 | 0.007 | 0.079 | 0.207 | 0.299 |
| LTN 8 | 0.057 | 0.012 | 0.114 | 0.251 | 0.227 |
| LTN 9 | 0.073 | 0.006 | 0.102 | 0.232 | 0.315 |
| LTN 10 | 0.069 | 0.019 | 0.102 | 0.246 | 0.280 |

From the Table 6, it is shown that the values of the calculated Sodium Adsorption Ratio (SAR) for the water samples range from 0.197 meq/l to 0.315 meq/l, making the water samples to fall within the excellent water class based on Sodium Adsorption Ratio assessment according to Hem 1959's water classification for irrigation purpose based on SAR (Table 7)

Table 7: Water classification for irrigation purposes based on Sodium Adsorption Ratio (SAR) (After Hem 1959)

| **SAR** | **WATER CLASS** | **QUALITY** |
|---|---|---|
| 0-10 | Excellent | Low sodium |
| 10-18 | Good | Medium sodium |
| 18-26 | Fair | High sodium |
| 26-100 | Poor | Very high sodium |

- **Biodiversity and Ecosystem Health**: The biodiversity of Lata na catchment is affected by deforestation where many of the trees in the catchment have been cut down for charcoal

production, leading to soil erosion and species loss. In order to have a high biodiversity rate and ensuring ecosystem health, reforestation and community engagement in sustainable tree management are essential.

- **Air Quality Index (AQI)**: Air quality Index is a scale that measures air quality from 0 to 500. It is a means of indicating levels of particulate matter or pollutants such as carbon monoxide (CO), sulfur dioxide ($SO_2$), and Nitrogen dioxide ($NO_2$) contained in the air. Air Quality Index is used to communicate how polluted the air is and the associated health risk. It ranges as follows:
    - **i.** Good ( if it ranges from 0-50)
    - **ii.** Moderate (if it ranges from 51-100)
    - **iii.** Unhealthy for sensitive groups (if it ranges from 101-150)
    - **iv.** Unhealthy (if it ranges from 151-200)
    - **v.** Very unhealthy (if it ranges from 201-300)
    - **vi.** Hazardous (greater than 300)

    The air quality of the Lata na catchment falls within the moderate range

- **Waste Management**: Environmental pollution and health challenges do arise from open dumping of wastes and bush burning which is a situation attached to this catchment. Proper modern waste management practices for better improvement should be developed and this includes provision of modern waste bins and sensitization of communities on proper disposal of wastes.

**Socio-Economic Assessment**

- **Demographic Profile:** The population of the Lata na Catchment is predominantly urban with a mixture of sedentary farmers and pastoralists. Population growth is high, contributing to increased demand for land and water resources.
- **Agriculture and Livelihoods**: Mixed farming is the type of agricultural practice dominating the catchment. The people of the area especially settlements like Patigi and Lafiagi depend for their livelihood on subsistence farming and rearing of domestic animals.
    - **Non-Farm Livelihoods**: Apart from agricultural practices in the area, other means of

livelihood of the people in the area includes trading and hoe blacksmithing.

- **Energy and Waste Management**: Firewood is the primary source of environmental pollution through burning activities especially in the rural communities of the catchment. This can be curbed by enforcing environmental policies on the people in the catchment to ensure stoppage of such activities

## Governance and Capacities Assessment

- **Policy and Regulatory Framework**: Natural resources in the catchment which are controlled by Nigeria's comprehensive policies and regulations designed to protect natural resources and promote sustainable development are to be monitored and enforced for good governance.
- **Key Governance Issues:** Governance in the catchment is challenged by inadequate basic social amenities such as good road especially Gbugbu - Lata na- Patigi road, pipe born water or boreholes, health care facilities, educational facilities etc. These issues can be solved through government interventions by providing good infrastructures and other basic social amenities for the communities in the catchment.

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**Conclusion**

The Lata na Catchment is a catchment that is underlained by the Sedimentary rocks mainly sandstones, siltstones and clay stones. The catchment has a total covering area of 342km$^2$. The catchment is distributed for its agricultural practices, vegetation cover and trading activities. The availability of water resources in the catchment is challenged by inadequate groundwater resource (boreholes) which needs government intervention especially during the dry seasons. The socio-economic activities of the people in the catchment are hindered by inadequacy in assessing social amenities which are good road, pipe borne water, health care and educational facilities which also need government intervention. The sustainability and quality of the water resources in the catchment for domestic and Agricultural purposes were revealed through the water quality analyses to be of good quality; physically, chemically and biologically but attention is called to improve the reduction in the level of nutrients available for plants as well as soapy-like taste of the drinking water by adding a sulphuric acid to the water through injection method to neutralize the carbonate by lowering the PH of the water.