Water Resources Uncertainty in Yewa River Basin, Ogun state, South-West Nigeria

O. A. Adeaga¹, A. A. Bello²,* and T. Akinbaloye²
¹Department of Geography and Planning, University of Lagos, Yaba, Akoka, Nigeria
²Department of Geography and Planning, Lagos State University, Ojo, Lagos, Nigeria
*E-mail address: yormybell@gmail.com

ABSTRACT

The paper examined water resources insecurity arising from climatic change and variability couple with increased population and economic development in in Yewa basin, with a view to understanding the relationship between climatic variables and hydrological parameters operating within the basin. Thus, the study entails assessment of the effects of climate change and variability on water resources and its implication on both physical environment and hydrological regime using water evaluation and planning (WEAP) system model. Data used include water supply and demand for Domestic, Commercial, Industrial and Agriculture as well as climatic data (rainfall and Temperature) and runoff. As revealed by the Scenario building, 45.24% of the annual water requirement within Yewa Basin is unmet with water potentials of Annual mean discharge of 3682.46 m³/s (±830.1) and Annual mean rainfall of 1106.26m (±475.25) with coefficient of variation of 40.88 and 73.73 respectively. This deficit calls for an appropriate water resources management mechanism in Yewa Basin.

Keywords: Water resources, Uncertainty, Climatic variability, Drainage basin, WEAP, Yewa River

1. INTRODUCTION

Global evaluation of water resources is becoming increasingly important in the context of rapidly global changing conditions as it relate to human induced drivers like population

( Received 24 May 2019; Accepted 12 June 2019; Date of Publication 13 June 2019 )
growth, changes in standards of living, industrialization, agriculture, land use changes and water use demand and patterns. Adding to this complexity is the changing climate resulting and its resultant effect on available fresh water resources. Optimized water management and planning scheme is essential for the improvement and monitoring of water resources availability, and with efficient water demand structure remains a key determinant for sustainable socio-economic development of a countries with shared water stressed resources.

Water resources evaluation is therefore a national responsibility that requires special arrangement and capability towards attaining an appropriate water resources assessment. Such evaluation is necessary since unabated increase in water demands and its fluctuation constitute issues of concern, in the planning and development of water resources, most especially in the area of water production and water utilization especially in the developing world (Shiklomanov, 1998; Jaji, 2007; Calamari, 1987; Martins, 1996; Olajire, 2001; Akpabio, 2007; Hughes, 2015).

Change in climate would have major impacts on natural and human systems. (Aerts, J.C.H., Droogers, P. 2004). The changes in the volume and the distribution of water will have impact on regional water resources. Therefore, precipitation is expected to vary considerably from region to region. However, with respect to hydrology, climate change significantly impacts water resource by resulting changes in hydrological cycle. For instance, the changes in temperature and precipitation can have a direct consequence on evapotranspiration and on both quality and quantity of the runoff components of the water balance. (Barnett, T.P, Adam JC, Lettenmaier, D.P. 2005).

Climate change is important to water planners and managers because it may change underlying water management conditions and increase the need for new water management programs and capital investments. Thus, in an attempt to overcome climate change challenges, the knowledge of basin-specific trends in the quantity and timing of water resources under emerging changing climate, will assist in the understanding localized sensitivity of available water resources. In addition intra-basin hydrologic dynamics will be highly desirable if issues relating to climate change uncertainty were understood since climate change presents new challenges to the way water manager’s plan for the future.

The impact of climate change and variability on water resources development are well recognize globally and have been identified as a major issues facing the availability of water resources, thereby creating threat to water resources. It is also established that the management and maintenance of water requires comprehensive and holistic approach in other to achieve sustainable water resources availability, management and development in any environment (Bello 2014). However, water resources management and planning requires a multi-disciplinary and holistic approach that brings together an array of expertise with varied interest to develop new efficient forecasting tools to process hydrological and water-related data and forecast the effects of different management strategies under the impacts of climate change uncertainty in other to achieve sustainable development.

Unfortunately the Yewa drainage basin’s water resources are under significant stress as demand continues to rise with population growth without significant improvement in available water resources. Over past decades, water supply has proved to be insufficient to deal with, strong competition for water with growing per capita water use while the need for domestic, industrial and agricultural water supply is growing, but the absence of appropriate demand management strategies means that increase in demand will likely outstrip the available supply (UNESCO 2006). Thus, imminent water scarcity in the Yewa basin, demand among other, a comprehensive evaluation of Water resources uncertainty in the Basin (Bello 2014).
The development of a Water Management Support System that integrates all current and future resources as well as all current and future demands into one tool, is crucial to the sustainability of the water resources management in Yewa river basin. Hence the needs for a plan that will allow for the sustainable and rational utilization, conservation and management of available water resources within Yewa river basin.

2. REGIONAL SETTING

Geographically, Yewa river basin lies approximately within latitudes 6.2° N and 7.75° N and longitudes 2.70° E and 3.00° E of the Greenwich Meridian. It is a trans-boundary river between Republic of Benin, where it rises and Nigeria. The basin has a total catchment area of approximately 5000 km² and it falls within Nigeria’s hydrological Area 6, which is under the jurisdiction of the Ogun- Osun River Basin Development Authority. It has a projected annual population growth rate of 2.77% and an annual runoff of 35.4×10⁹ m³ or depth of runoff of 352mm per year (Federal Dept. of Water resources, 1986). By virtue of its location the basin has a predominantly rural economy with over 80% of the population engaged in agriculture. During the dry season, the main means of livelihood in the basin is recession or flood plain farming. Ilaro, Owode, Ajilete, Idiroko, Oja Odan, Oke-Odan, Ilase, Yewa-Matta, Ijaka-Oke, Ebute-Igboro, Idogo, Igan-Alade, Igbofila, Egua, Ketu and Badagry are some of the important towns in the basin. (Oyebande and Adeaga 2007). The basin will most likely become more rapidly urbanized in the next decade as a result of recently established Dangote Cement Factory at Ibesee via Ilaro, In addition to Ota and Agbara industrial zone coupled with population influx from Lagos metropolis into the Yewa catchment. It may therefore in effect be a basin in transition from a rural one to an urbanized one. There is increasing urban socio-economic influence from Lagos metropolis and this has led to increasing per capita water demand and greater pressure on available freshwater resources which has often result in mass uncoordinated surface and groundwater resource withdrawals. Thereby creating water stressed basin. Fig. 1. Showing Yewa drainage basin.

Yewa river basin is one of the reference river basins to Ogun-Osun river basin development authority with inequity issues of water availability among different water users which brought about by rising population in conjunction with Climate change and industrial development. This greatly responsible for the resources management challenges in the basin which include lack of proper allocation of the resources, inefficient and ineffective environmental monitoring and lack of policies for sustainable water uses (Bello 2014).

Climatologically, the basin is located in the moderately hot, humid tropical climatic zone of south western Nigeria which is under the influence of the tropical continental (CT) air mass and the tropical maritime (MT) air mass. The narrow zone of convergence of the two air masses is called the Intertropical Convergence Zone (ITCZ), which usually shifts seasonally with the pressure belts and Isotherm. There are two distinct seasons; the wet season begins from March/April to October/November and the dry season which last for the rest of year starts from October/November till March/April.

The temperature is relatively high during the dry season with the mean annual temperature in the basin is about 26 °C in the south and 28 °C in the north with an annual range of ± 4 °C. The harmattan which brought in the North-easterly wind from December to February has ameliorating effect on the dry season and low temperature is experienced during the raining
season especially between July/August when the temperature could be as low as 24°C. However, rainfall in Yewa drainage basin generally decreases from the south to the north and varies from about 1500 mm in the south to about 800 mm in the north (Adeaga 2007).

Fig. 1. Yewa Drainage Basin and major settlement in Ogun State Nigeria.

2. WATER RESOURCES POTENTIAL AND CURRENT SITUATIONS IN YEWА BASIN

The water resources potentials of Yewa river basin is very enormous with high intensity and long duration of rainfall; the region is endowed with adequate water in perennial rivers and groundwater. In spite of this abundant water potential, available public water scheme across the basin are severely limited and accessible to less than 40% of the population. People have to individually source for water through laborious, time consuming and sometimes expensive alternative. This situation has produced a thriving water sales business from the single cottage water merchant with a single well or borehole with a generator and an overhead tank connected.
to one or more dispensing taps, to the big time players with fleets of water supply tankers, the business continues to grow in leaps and bounds, mostly in some urban settlements in responses to population growth and lack of public water supply.

In the poorer areas of urban settlements rainwater collection augment supplies from local water sellers to keep costs down and stream water which mostly depends upon is usually absolutely unsafe with pollutions from both domestic and industrial waste, but this is still used by very many people. The rural areas rely mostly on hand dug wells and water from streams and small rivers to meet their needs and usually augment this with harvested rainwater.

Subsequently, the combination of the above factors in addition with poor sanitation result into serious health problems in some of the rural areas as well as other parts of the urban settlements and no major solution appears to be on ground (Bello 2014).

3. METHODOLOGY

Data on water supply and demand for domestic, industrial, commercial were obtained from Ogun State Water Corporation Abeokuta. Other data set include irrigation water requirement, reservoir capacity, location and operation rules, gauge heights, river head flows and Climatic data, (rainfall and temperature) were obtained from Ogun-Osun River Basin Development Authority (Abeokuta) while population data for the Basin was obtained from National Population Commission, Abeokuta.

Water Evaluation and Planning (WEAP) model was used to evaluate the effect of Climatic change and variability on water resources in Yewa basin. In the study, water development and management evaluation were carried out in respect of multiple and competing water uses system, while the configuration and geo referencing of the map of the Basin was in compatibility with the WEAP software format as shown in Fig. 2. WEAP Model is a powerful but easy-to-use computer based system that has been developed for water management, planning and water allocation, integrating information on Climate change uncertainty, water availability and quality.

The Water Evaluation and Planning Model, WEAP software developed by the SEI was chosen for the study to enable evaluation of planning and management issues associated with water resources development. WEAP system is a demand, Priority and preference driven water planning model, it aims at closing the gap between water management and catchment hydrology by addressing both bio-physical factors influencing the river and socio-economic factors affecting demand and management of the resources. It is designed as a comparative analysis and easy to use simulation tools based on water balance accounting principle which test alternative set of condition of both supply and demand which can be applied to both municipal and agricultural systems and can address a wide range of issues including sectoral demand analyses, water conservation, water rights and allocation priorities, stream flow simulation, reservoir operation, ecosystem requirements and project cost-benefit analyses and Climate change (SEI 2001).

The model optimizes water use in the catchment using an iterative Linear Programming algorithm, whose objective is to maximize the water delivered to demand sites, according to a set of user-defined priorities. All demand sites are assigned a priority between 1 and 99, where 1 is the highest priority and 99 the lowest. When water is limited, the algorithm is formulated to progressively restrict water allocation to those demand sites given the lowest priority.
WEAP model has two primary functions: Simulation of natural hydrological processes (e.g., evapotranspiration, runoff and infiltration) to enable assessment of the availability of water within a catchment, and Simulation of anthropogenic activities superimposed on the natural system to influence water resources and their allocation (i.e., consumptive and non-consumptive water demands) to enable evaluation of the impact of human water use. The Water Evaluation and Planning (WEAP) model attempts to address the gap between water management and watershed hydrology and the requirements that an effective IWRM be useful, easy to-use, affordable, and readily available to the broad water resource community (Yates, 2005a). In addition, the data structure and level of detail may easily customize to meet the requirements of a particular analysis and to reflect the limits imposed when data are limited (Yates et al., 2005b).

The model essentially performs a mass balance of flow sequentially down a river system, making allowance for abstractions and inflows. To simulate the system, the river is divided into reaches. The reach boundaries are determined by points in the river where there is a change in flow as a consequence of the confluence with a tributary, or an abstraction or return flow, or where there is a dam or a flow gauging structure. Typically, the WEAP model is applied by configuring the system to simulate a recent “baseline” year, for which the water availability and demands can be confidently determined. The model is then used to simulate alternative scenarios (i.e., plausible futures based on “what if” propositions) to assess the impact of different development and management options.

The users can project changes in water demand, supply and pollution over a long time of planning horizon to develop adaptive management strategies. To allow simulation of water allocation, the elements that comprise the water demand-supply system and their spatial relationship are characterized for the catchment under consideration. The system is represented in terms of its various water sources (e.g., surface-water, groundwater, desalinization and water reuse elements); withdrawal, transmission, reservoirs, and wastewater treatment facilities, and water demands (i.e., user-defined sectors but typically comprising industry, mines, irrigation, domestic supply, etc.). The data structure and level of detail can be customized (e.g., by combining demand sites) to correspond to the requirements of a particular analysis and constraints imposed by limited data. A graphical interface facilitates visualization of the physical features of the system and their layout within the catchment as indicated by Fig. 2 showing schematic view of the model of Yewa basin. More details of the model are available in (SEI 2001).

Basic assumption in the input into the model for the current situation and the scenario building simplification of the demand site include a population growth rate of 2.1% as indicated in Table 1. Slight technological irrigation efficiency, complementary source of water from Private Borehole, hand dug well and rainwater harvest. It should be noted that groundwater was not given consideration in the study due to data set scarcity. For model scenario building, the main output analyzed was the degree of satisfaction of the water demands in different sectors as indicated in table 2. Consideration was also given to other output such as Stream flow in the basin. Finally, the different climate change scenarios building on the impact of the increasing water demands, increasingly higher population, Changes in climatic variability, complimentary water use and improvement in the irrigation technology were estimated, among others.

The water year method allows the usage of historical data in a simplified form that explores the effects of future changes in hydrological patterns. The method is a useful tool in testing hypothetical event and helps to understand and explore in simple ways the climatic

-42-
change sensitivity as derived from the fractions of historical flows using statistical analysis. The historical records are grouped into five sets and then their variation from the normal is computed to attain the sensitivity coefficient based on the average annual inflow for the study period 2013 to 2025. The results of the scenario help to supplement the previous simulated method and the normal water year average.

![Diagram of Yewa River Basin]

**Fig. 2.** Schematic view of Yewa River Basin.
Source: author 2014

The reference scenario for analysis covers the period 2014-2025, in order to assist the planner and water resources manager to fully understanding the likely implication of continuation of the current trend without understanding the real situation as pointed out in Table 3. Furthermore, it helps in designing contingency plan where there is a lot risk and uncertainty, since the reference scenario replicates the real situation.
Table 1. Yewa River Basin Population 2006.

| Population | 1,112,761 Persons |
| Growth rate | 2.1% |

Source: National Population Commission 2014

Table 2. Water Demand and Supply Data 1982-2013.

<table>
<thead>
<tr>
<th>Demand Sites</th>
<th>Commercial</th>
<th>Domestic</th>
<th>Industrial</th>
<th>Ogun-Osun Irrigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Activities (10^6 m^3)</td>
<td>17.1</td>
<td>10.4</td>
<td>35.142</td>
<td>320</td>
</tr>
<tr>
<td>Annual Water Rate %</td>
<td>3.64</td>
<td>6.15</td>
<td>1.78</td>
<td>42.14</td>
</tr>
</tbody>
</table>

Source: Ogun State Water Corporation 2014

Table 3. Average Monthly River Flow (m^3 s^-1) (1982-2011).

<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper stream</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td>0.14</td>
<td>0.34</td>
<td>1.2</td>
<td>2.13</td>
<td>2.26</td>
<td>1.97</td>
<td>1.29</td>
<td>0.33</td>
<td>0.16</td>
</tr>
<tr>
<td>Middle stream</td>
<td>4.02</td>
<td>4.39</td>
<td>4.17</td>
<td>6.78</td>
<td>8.46</td>
<td>9.43</td>
<td>12.38</td>
<td>10.32</td>
<td>9.17</td>
<td>4.96</td>
<td>3.01</td>
<td>2.29</td>
</tr>
<tr>
<td>Lower stream</td>
<td>16.02</td>
<td>16.88</td>
<td>17.43</td>
<td>17.94</td>
<td>20.02</td>
<td>22.71</td>
<td>25.63</td>
<td>26.03</td>
<td>23.03</td>
<td>20.03</td>
<td>17.4</td>
<td>10.7</td>
</tr>
</tbody>
</table>


4. RESULTS ANALYSIS AND DISCUSSION

4.1. Water Resources in Yewa River Basin

Investigation from the study revealed that Yewa river basin is endowed with lot of water resources, major sources of water supply in the area includes but not limited to Ground water, Surface water and Rain water. It is interesting to note that enormous water resources are available due to the strategically location of the basin but not without water scarcity. According to Fig. 3 and Table 4, it was revealed that the Annual mean rainfall distribution of 1202.16 mm was recorded at the upper stream, Ijaka oke gauging station of the basin while the middle
stream, Ebute-igboro gauging station recorded 1170.4mm annual mean rainfall distribution, and the Lower stream of the basin, Ajilete gauging station recorded annual mean rainfall distribution of 946.18mm all within the period of (1982-2011). However, indication from fig 3 revealed that rainfall distribution increases from the months of May to November, thereby increasing the volume of the stream flow for the period.

According to the Table 4 the Mean annual discharge for the Upper stream, Ijaka Oke gauging Station for the period (1982-2011) was 135.70 m³/s and the Mean annual discharge for Ebute-Igbooro gauging station, middle stream was 3095.71 m³/s while it was revealed that Ajilate gauging station the Lower stream was 7815.97 m³/s. However, the shortfall recorded in the runoff at Ijaka Oke station could be attributed to strategic location of the station as the Upper stream of the basin.

![Fig. 3. Annual River Flow m³/s for the year (1982-2013)](image3.png)

![Fig. 4. Probably Annual Inflow to the Area in Yewa River Basin. (2013-2025).](image4.png)
In addition, the probability of the annual inflow to the basin is a function of the climatic variability prevailing at that period, this was revealed by fig4 indicating probably annual inflow to the area. Estimated coefficient for the water year definition are 0.7, 0.8, 1.0, 1.3, and 1.45 for very dry, dry, normal, wet and very wet respectively. The water year definition specifies how much more or less water flows into the system in that year relative to a normal water year as indicated in Fig. 3 and Fig. 4 shows the probably annual inflow to the basin for the period of (2013-2025).

Fig. 5. Annual Unmet Demand for Various Water Use in 10^6 m^3

Fig. 6. Monthly inflow and outflow of River Yewa Rate of Consumption 10^6 m^3
The unmet water resources observed at the basin was largely due to climatic variability that was insignificant at the onset, but as the annual variation increases from year to year the water consumption increases and this tend to be visible on the unmet water. Significantly, the annual variation in rainfall was the function of change in climate that was experienced at the basin. The annual unmet demand for various water uses at different demand sites were indicated in Figure 5. Obviously, it indicates the unmet demand for domestic water use, $4.5 \times 10^6 \text{ m}^3$ while the others show little or no unmet demand. However, the expected increase in population growth rate and increase in the standard of living of the people would invariably increase water uses that has already been impacted by climatic variability.

Furthermore, it is interesting to note that increase in climate variability is expected to alter the present hydrological regime of the basin and add pressure on the available water resources for the future as indicated in Fig. 6 showing the inflow and outflow of water for the year while the increase in the river is attributable to the rainfall distribution pattern in the basin caused by climatic variation. However, the spatial distribution of rainfall is expectedly high between the months of May - November, thereby increasing the volume of the stream flow for the period. For instance Fig. 7 shows expected river flow variability in the basin for the period of (2013 to 2025).

![Figure 7: Probably River Flow Variability in Yewa River Basin (2013-2025).](image_url)

**4. 2. Water Demand and Supply Scenario Building of Yewa River Basin (2013-2025)**

Water demand for various demand sites vary according to water use rate. As the population within the basin increases, water demand at various demand sites also increases. For instance the demand for domestic activities is $14.02 \times 10^6 \text{ m}^3$ which happened to be the highest amount while commercial activities and industrial have $8.29 \times 10^6 \text{ m}^3$ and $4.05 \times 10^6 \text{ m}^3$ respectively with irrigation demand having $1.75 \times 10^6 \text{ m}^3$. However, the result shown that
irrigation has very marginal increment in water demand in the basin, this could be attributed to slight technological irrigation efficiency cum low level of irrigation practices in the basin. The projected annual Water demand for various uses among the demand sites is shown in Fig. 8.

![Projected Annual Water Demand for Yewa River Basin (2013-2025)](image)

**Fig. 8.** Projected Annual Water Demand for Yewa River Basin (2013-2025)

### 4.3. Water Resources Potential of Yewa Basin

According to the data from the Table 4. The Mean annual discharge for the Upper Stream, Ijaka Oke gauging station for the period (1982-2011) was 135.70 m$^3$/s and the Standard deviation was 224.03 while the Coefficient of variation stood at 165.09. It is interesting to note that 929.39 m$^3$/s was recorded as the maximum discharge in the year 2010 while 14.77 m$^3$/s was recorded as the minimum discharge in the year 1983, this variability could actually be attributed to Change in Climate. However, the shortfall recorded in the runoff at Ijaka Oke station was as a result of strategic location of the Station, Upper stream of the basin. As it shown in Fig. 9. Indication from Table 4 revealed that the annual mean discharge of Ebute-Igboro gauging station the Middle Stream was, 3095.71 m$^3$/s and 1391.36 for Standard deviation while 44.9 was the Coefficient of Variation, in addition, 6689.59 m$^3$/s was the maximum discharge while the minimum discharge was 1283.89 m$^3$/s. However, Fig 10. Showing analyses of the runoff at Ebute-Igbooro gauging station within the period (1982-2011) clearly shows that the station has high variability of runoff, with the implication of wetter year as well as dry year within the season.

Furthermore, at the lower Stream in Fig. 4 the analyses revealed that the mean annual discharge for the period (1982-2011) was 7815.97 m$^3$/s and the standard deviation was 874.64 and the Coefficient of Variation was 11.19. However, Maximum and Minimum discharge of the station was 11495 m$^3$/s and 6625.7 m$^3$/s respectively. It is interesting to mention that among the three gauging stations as shown in Fig. 11 that Ajilete gauging station shows higher
variability than the rest of the stations. Rainfall distribution as indicated in Table 5 for Upper stream, Ijaka-Oke gauging station reveals that 1202.16 mm of precipitation was recorded as annual mean while the Standard deviation was 441.61 and the Coefficient of Variation was 36.74. In other words the maximum rainfall distribution of 2903.6 mm was recorded in the year 2000 and the minimum rainfall distribution of 104.3 mm happened to be in the 2001.

The Annual Mean rainfall distribution in Table 5 for Middle stream Ebute-Igbooro gauging station happened to be 1170.4 mm while the Standard Deviation was 614.2 and the Coefficient of Variation was 52.5 as indicated in Table 5, this showed that the maximum rainfall distribution was 2173.6 mm in the year (2003) while the minimum rainfall distribution was 73.04 mm in the year (1998).

However, Table 5 indicated an Annual mean Rainfall distribution of 946.18mm was recorded at Lower stream, Ajilete gauging station within the period (1982-2011), and the standard deviation was 315.95, while 33.39 was recorded as Coefficient of Variation as indicated and the maximum and minimum rainfall recorded was 1495 mm and 65.42 mm respectively under the year 2006 and 1997. To be more precise there was low rainfall at this station, but high variability of runoff, as indicated in Fig. 11, the implication is the downstream location of the station with more concentration of runoff along the channel.

Observation from rainfall-runoff analysis indicate that the basin has a very great water resources potentials judging from fact that the annual mean discharge of all the stations was 3682.46 m$^3$/s and the annual mean rainfall was 1106.26 mm. To buttress this 830.1 was the discharge’s Standard deviation for the whole station while it was 475.25 for precipitation and 73.73 was discharge’s Coefficient of Variation thus precipitation Coefficient of Variation was calculated to be 40.88.

**Table 4.** Analysis of Hydrological Parameter Discharge m$^3$/s (1982-2011).

<table>
<thead>
<tr>
<th>R. Station</th>
<th>Annual Mean</th>
<th>Std. Deviatn.</th>
<th>Coef. of Var.</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper stream</td>
<td>137.70</td>
<td>22.03</td>
<td>165.09</td>
<td>929.39</td>
<td>14.77</td>
</tr>
<tr>
<td>Middle stream</td>
<td>3095.71</td>
<td>1391.36</td>
<td>44.9</td>
<td>6689.59</td>
<td>1283.89</td>
</tr>
<tr>
<td>Lower stream</td>
<td>7815.97</td>
<td>874.64</td>
<td>11.19</td>
<td>11495</td>
<td>6625.7</td>
</tr>
</tbody>
</table>

**Table 5.** Analysis of Hydrological Parameter Rainfall Distribution mm (1982-2011).

<table>
<thead>
<tr>
<th>R. Station</th>
<th>Annual Mean</th>
<th>Std. Devia.</th>
<th>Coef. of Var.</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper stream</td>
<td>1202.16</td>
<td>441.61</td>
<td>36.74</td>
<td>2903.6</td>
<td>104.3</td>
</tr>
<tr>
<td>Middle stream</td>
<td>1170.4</td>
<td>614.2</td>
<td>52.5</td>
<td>2173.6</td>
<td>73.04</td>
</tr>
<tr>
<td>Lower stream</td>
<td>946.18</td>
<td>315.95</td>
<td>33.39</td>
<td>1495</td>
<td>65.42</td>
</tr>
</tbody>
</table>
Fig. 9. Annual Discharge & Rainfall Distribution for Ijaka Oke (1982-2011) (Upper Stream)

Fig. 10. Annual Discharge & Rainfall Distribution for Ebute-Igbooro Station (1982-2011) (Middle Stream)
5. CONCLUSIONS

Water is a limiting resource for development, a change in water supply and demand could have major implication in socio-economic affairs of the populace. Since water demand vary according to water use rate as the population within the basin increases, water demand also increases. It was revealed that the main consumption in Yewa River Basin is the domestic demand follow by commercial and industrial demand while the Ogun Osun irrigation project has low level of water demand which resulted from efficient irrigation technological practices, more so the major concerns in the basin is the sustainability of the current and future water resources.

However, It was discovered that the current water management mechanism were inefficient and policies were not tailored at ensuring that the existing supply of water meets the growing demand, whilst some of the mechanism are inappropriate to deal with the future shortage that might be brought about by climate variation.

Limitation in water resources are posing a lot of constraint to economic development and health in the Yewa basin thereby making economics cost to be likely high thereby increasing the risk of poverty and hunger. Rainfall variability is one of the features in the basin which is harmful to stability and security of water resources in the basin. In addition, the study also revealed the impact of climatic variability on water resources and consequently on people’s livelihood and health. Hence, there is need for robust long term holistic strategies that would ensure that the futuresupply of water matches demand sustainably.

Also, there is need to be proactive in tackling the challenges of unmet water demand to avoid impending water crisis, and appropriate solution should therefore include but not limited
to setting up of water metering system through data acquisition and proper water demand allocation management.

Furthermore, there is need for optimization of Yewa River Basin resources for need of its population; therefore a strategic planning of water resources development is required in other to ensure sustainable water use in the basin.

References


