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Forecasting Of Water Supply In Bekaji-Jimeta, Adamawa-Nigeria

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***Abstract:** In this research forecasting of water supply of Bekaji-Yola, Adamawa state of Nigeria. Literatures were reviewed about the water supply situation of Bekaji, Adamawa and Nigeria as a whole. The iteration method of R-Studio packaged was ussed under ARIMA (1,0,1) model specifically to analyze the present and future water demand of Bekaji Community. The results of the analysis revealed that The demand range for 2017 was 49.97265cu.m to 50.76489cu.m and the average demand was 50.3588, the forecast range for 2018 is 50.82904 to 51.45986 and the average demand is 51.1544, the forecast range for 2019 is 51.51094cu.m to 52.01323cu.m and the average demand is 51.7700, finally the range for 2020 is 52.05390 to 52.45388cu.m and the average demand is 52.2602.cu.m. The annual water demand of Bekaji is 21900cu.m (that means averagely each person consumes 21900 yearly. The projected values of water demand will be from 2018-2020 which means as the population of Bekaji increaeses the demand of water will increase.*

***Keywords:** Bekaji, Box-Jenkins, Forecasting, Water Supply*

I. INTRODUCTION

Water is a liquid which made up of over 50% of the blood in human being and other animals. “Water is a transparent, tasteless, odorless, and nearly colorless chemical substance that is the main constituent of Earth's streams, lakes, and oceans, and the fluids of most living organisms’’ (*https://en.wikipedia.org/wiki/Wate)*. Adequate water supply is very essential life survival. Water is the most important among the five basic human needs, namely: water, health, peace, and food (National water policy 2004).

As observed by Vermersch (1996) water is special in the sense that it has a special role in community’s perception. Subconsciously people recognize that it is vital to their everyday existence, It has association with health purity and beauty. Water is usually thought to be abundant and available gifts from nature that ought to be free of charge.

Increasing pressures of population growth, urbanization, costs, and shortages of resources, environmental pressures, and evolving technology are causing rapid changes. These changes require level of investment that most politicians are unable to reconcile with other political imperatives.

Meinzen-Dick and AnnJackson (1996) asserted that water is one of the indispensable chain links of a national economy and has many uses for man other than human consumption. It is necessary for industrial uses, for irrigation in areas of insufficient rainfall and in generation of electric power. If water resources are carefully planned and supervised, they can also help to meet growing demand for outdoor recreation transportation and communication.

Water as natural phenomenon exists or can be obtained from two main sources. The sources are surface and ground water. Surface water refers to the sources of water that exist in their natural state, this include rain, rivers and lakes. On the other hand, ground water refers to the sources such as boreholes, wells and springs which are purer than the surface water. Being a vital element in the lives of all living things and considering its pathogenic nature i.e. ability to transmit diseases and micro-organisms, water need to be treated to become fit for drinking or what is known as portable pure water.

According to Adejuyigbe and Oke (2006) pure water is that which is suitable for drinking and a commodity, very scare to come by in so many communities; both rural and urban. In extreme cases of water scarcity, water related diseases such as typhoid and paratyphoid fevers, dysentery and cholera are common place.

Availability of adequate and dependable supply water for domestic, agricultural and industrial purpose is vital for a meaningful and sustained social and economic development (Mabogunje, 1965) cited in (Ayoade and Oyebande, 1978). Industry in particular makes use of water as an ingredient with other raw materials to create finished products as a transporting medium, as a cleansing agent and as a source of steam for heating and power generation. Hence, there is a need for every community to know their present quantity of water they have, the quantity of water they need and how to coup with future water demand, (industry report 2017).

The research carried out by Chukwuma (2017) revealed that about 663 million of world don't have sufficient drinking water and about halve of the population of those using impure water lives in Sub-Sahara Africa. In Nigeria, like in most developing countries of the world it is very difficult for people to get constant supply of water, hence people have learn to purchase the scarce commodity from tankers and water vendors. The study carried out by Adewusi (2015) revealed that good number of Nigerian population don't have access to pure water supply. As the result of this many suffer from water born diseases while several others have died. Unfortunately, water scarcity has retarded the rate of economic growth, because it led to the shortage of water supply to industries for commercial purposes. Most industries use boreholes to generate water for their consumption. Such boreholes do not have a wider network to supply water into places where it is needed. This makes water unavailable. Furthermore, inadequate information on water resources together with lack of Technology and usability has become one of the major hurdles to portable water supply and accessibility in several less developed countries.

Access to clean water reflects the health status of a country. Safe water includes treated surface water, as well as untreated but uncontaminated water from source such as natural springs and sanitary wells and protected boreholes (lshaku *et al.*, 2011). On average, a person needs about 20 liters of safe water each day to meet his or her daily metabolic, hygiene and domestic needs. In urban areas the source may be public standpipe located not more than 200 meters away. In rural areas, it implies that members of the household do not have to spend a disproportionate part of the day fetching water (World Bank Group, 2002).

On the other hand, lack of access to potable water supply leads to incidences of death and illness. In most rural and peri-urban communities, residents spend considerable amount of time in fetching water, this time expended on sourcing water can be used for other activities. The World Bank Group (2004) reported that about 3.5 billion people worldwide (54%) had access to piped water supply house connections. Another 1.3 million (20%) had access to "improved water source" through other means than house connections including standpipes. Finally, more than 1.2 billion people (16%) did not have access to improved water source, meaning that they have to revert to unprotected wells or springs canals, lakes or river to fetch water. It should be noted however, that access to an improved source of water does not necessarily imply that it is safe to drink from that source. A large proportion of the per urban population in the state relies on informal and private water providers, little is

Known about the way citizens cope with unreliable water supply in the rural and per-urban communities (Ogunbanjo, 2004) and (Jijani, 2003) cited in Olaposi (2009). In addition, physical assessment of many public supplied pipe-borne water samples also testified to their poor quantity.

Hence this research work is focusing toward assessing the water demand of Bekaji community of Adamawa state as well as estimating the future demand. This would go a long way of developing some strategies that would coup the future challenge of availability and quality of water supply in the Bekaji community.

II. PARAMETER ESTIMATE

Parameter estimation is used to find the value of model co-efficient, which provides the best fit of data. But for this research work, the iteration method of R packaged was ussed under ARIMA (1,0,1) model. The following parameter were estimated:

An ARIMA model is typically expressed as: ARIMA (p,d,q) where p is the order of autoregression, d is the order of differencing (or integration), and q is the order of moving average involved.

An AR (1) or ARIMA (1,0,0) process has the following function form:

Value_t $=$ coefficient *value$_{t-1}$ $+$ disturbance$_t$

where:

Value = the value of the series at time t.

Coefficient = a value that indicate how strongly each value depend on the preceding value

Disturbance = the chance error associated with the series value at time t.

The standard shorthand for integrated models that need to be difference is I (0) or

ARIMA (1,0,0). The order of the moving-average process specifies how many previous disturbances are averaged into the new value. An MA(1) or ARIMA (0, 0, 1) has the functional form:

Value = coefficient * disturbance + disturbance.

Where:

Value = the value of the series at time t

Coefficient = a term that indicate how strongly each value depends on the preceding disturbance terms

Disturbance = the chance error associated with the series value at time t

This simply means finding the value of the model coefficient, which provides the best fit to the data.

There are several different models for estimating, the most method uses maximum likelihood estimation or non-linear least square estimation. But for the of this research work, the iteration method of R-Studio package was used . The following parameter were estimated under ARIMA (1, 0, 1)

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		Estimate	SE
Constant	49.5537	1232	6.6202
AR	Lag 1	0.7061	0.1236
MA		-0.3543	0.1588

Table 1: Parameter Estimation of ARIMA (1,0,1)

Model	AIC	BIC
ARIMA(1,0,1)**	1320.21	1333.737
ARIMA(2,0,1)	1320.54	1336.95
ARIMA(3,0,1)	1322.43	1341.727
ARIMA(1,0,2)	1321.57	1337.981
ARIMA(2,0,2)	1322.37	1341.664
ARIMA(3,0,2)	1323.72	1345.897
ARIMA(4,0,2)	1324.34	1349.406
ARIMA(1,0,3)	1322.9	1342.196

*** is selected as the best model for the data*

Table 2: The result table for the values at different orders is given below

The above table are all models used to run the data. The test was conducted to know the significant level of each (i.e to know which parameter contributes significantly to the model). The Akaike information criterion (AIC) and bayesian information criterion (BIC) are used to conpare the model, so as to know the smallest model.

III. FORECASTING

Table 3 presents future forecast of monthly water supply in Bekaji(in thousand liters). Using the Software R

2016	Forecast	
January	48.89712	37.92658
February	48.9960	37.99269
March	49.09381	38.05585
April	49.18939	38.11655
May	49.28318	38.17490
June	49.37520	38.23099
July	49.46548	38.28492
August	49.55407	38.33676
September	49.64100	38.38661
October	49.72629	38.43453
November	49.80997	38.48062
December	49.89208	38.52493
2017	Forecast	Standard Error
January	49.97265	38.56755
February	50.05170	38.60853
March	50.12927	38.64795
April	50.20537	38.68586
May	50.28005	38.72232
June	50.35332	38.57739
July	50.42521	38.79113
August	50.49575	38.82357
September	50.56496	38.85479
October	50.36288	38.88482
November	50.69951	38.91370
December	50.76489	38.94149
2018	Forecast	Standard Error
January	50.82904	38.96823
February	50.89199	38.99395
March	50.95375	39.01870
April	51.01435	39.04251
May	51.07381	39.06542
June	51.13215	39.08746
July	51.18939	39.10867
August	51.24556	39.12908
September	51.30067	39.14872
October	51.35474	39.16762
November	51.40780	39.18580
December	51.45986	39.20330
2019	Forecast	Standard Error
January	51.51094	39.22014
February	51.56106	39.23635
March	51.61024	39.25194
April	51.65849	39.26695
May	51.70584	39.28140
June	51.75229	39.29530
July	51.79787	39.30867
August	51.84259	39.32155
September	51.88648	39.33394
October	51.92953	39.34587
November	51.97178	39.35735
December	52.01323	39.36839
January	52.05390	39.37903
February	52.09381	39.38026
March	52.13297	39.39911
April	52.17139	39.40859
May	52.20909	39.41771
June	52.24608	39.42650
July	52.28237	39.43495
August	52.31798	39.44309
September	52.35292	39.45092
October	52.38721	39.45846
November	52.42085	39.46572
December	52.45385	39.47270

Table 3: Future forecast of monthly water supply in Bekaji

IV. RESULTS AND DISCUSSION

The result of the forecast as shown in table 3 reveales that the quantity of water demand in Bekaji increases with time. The following are forecast ranges and averages of water demand from 2017- 2020.

The forecast demand range for 2017 is 49.97265cu.m to 50.76489cu.m and the average demand is 50.3588, the range for 2018 is 50.82904 to 51.45986 and the average demand is 51.1544, the range for 2019 is 51.51094cu.m to 52.01323cu.m and the average demand is 51.7700, finally the range for 2020 is 52.05390 to 52.45388cu.m and the average demand is 52.2602.cu.m.

From the above table it was observed that the population of Bekaji increases yearly and the quantity of water demand by each person in Bekaji is 60cu.m, and the average dialy demand of water is 6,505,140cu.m and its resulted to 406,571 (i.e the water projected population in Bekaji) The annual water demand of Bekaji is 21900cu.m (that means averagely each person consumes 21900 yearly. The projected values of water demand will be from 2018-2020 which means as the population of Bekaji increaeses the demand of water will increase.

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YEAR	POPULATION	Average Daily Demand(cu.m) In Bekaji	Annual water demand in the Bekaji
2005	5000	300000	109,500,000
2006	5120	307200	112,128,000
2007	5408	324480	118,435,200
2008	5820	349200	127,458,000
2009	6832	385920	149,620,800
2010	6526	391560	142,919,400
2011	6724	404280	147,255,600
2012	6924	435780	151,635,600
2013	7263	415440	159,059,700
2014	7485	435780	163,921,500
2015	7648	458880	167,491,200
2016	7865	471900	172,243,500
2017	7742	464520	169,549,800
2018	7663	459780	167,819,700
2019	7562	453720	165,607,800
2020	7445	446700	163,045,500

Table 4: Water Demand Of Bekaji

V. CONCLUSION

The paper was to forecast the monthly water supply for Bekaji, the general pattern of monthly water supply was studied through the Box-jenkins model. A model for forecasting future monthly water supply was identified and determined based on the data for the period of 2005-2015. The study revealed that water demand in Bekaji increases with the population.

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