ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 4, Issue 10 , October 2017

Using Monte Carlo Simulation Technique to account for the location of Public Water Scheme in Rural Abia State

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ABSTRACT: Monte Carlo simulation technique was used to examine the factors underlying the location of a public water scheme in Nbawsi, Abia State, instead of other locations. One hundred copies of questionnaire were distributed, while 84 were retrieved. Data retrieved were subjected to mathematical procedures of Monte Carlo simulation technique. Subsequently political interest among other factors recorded the highest mean value of 0.1488 in the probability growth matrix. Other mean values are as follows: presence of reservoir, 0.0208; distance function, 0.0268 and population distribution, 0.0536 among other things, we recommended that the decentralization of water schemes will enhance operational efficiency, remove technical complexities arising from reticulating water to a larger area and promote community participation in operational processes.

1. INTRODUCTION

In line with the concept of information difference by hagerstrand (1965), Public water schemes were located at centers of most equidistance to the catchment areas. These centers can be classified as Mean Water Generation Centers (MWGC) with distribution networks spreading outwards. Ayeni (1994), Alozie, (2001), Chima (2000) and Madu (2014) at different with similar circumstances noted that distance this work effectively against the spread effect mechanisms. Distance this is expressed as barriers to equitable distribution of water from the water schemes. The hummers include; terrain characteristics, incremental costs, welfares, ideologies, examine dynamics, political favoritism and sociology of traditional bias. It is for this purpose that this paper will scrutinize the reasons behind the choice of the varies locations for sitting water schemes in the area using Morte Carlo simulation techniques. As should be expected, technical, hydrological terrain characteristics and population derivation should be paramount in directing decisions on the selection of most suitable sites for locating public water schemes in the area. Nonetheless, the research would reveal an irregular pattern in reasons guiding the selection of sites for installing public water schemes in the area.

A. Theoretical Framework

Hagerstrand (1965) defined Mote Carlo simulation techniques as a game of the dice in which the gaming table represents a part of the earth's surface, the pieces represent individuals living in the area and the rules of the game constitute the particular factors which we want to study. Morill, (1965) however considered it a stochastic model of an experimental procedure for the mathematical evaluation where unique mathematical solution is possible. Ackoft(1962), Ayeni (1979), Alozie 2001 and Alozie (2002) literally confirmed that four uses of the Model are very certain. They Include:

1) It can be used to determine the values of control variables
2) Test the effects of changes in probability values and parameters.
3) To trace the trajectory of dynamic systems and the estimation of parameters and carrying out of sensitivity analysis

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

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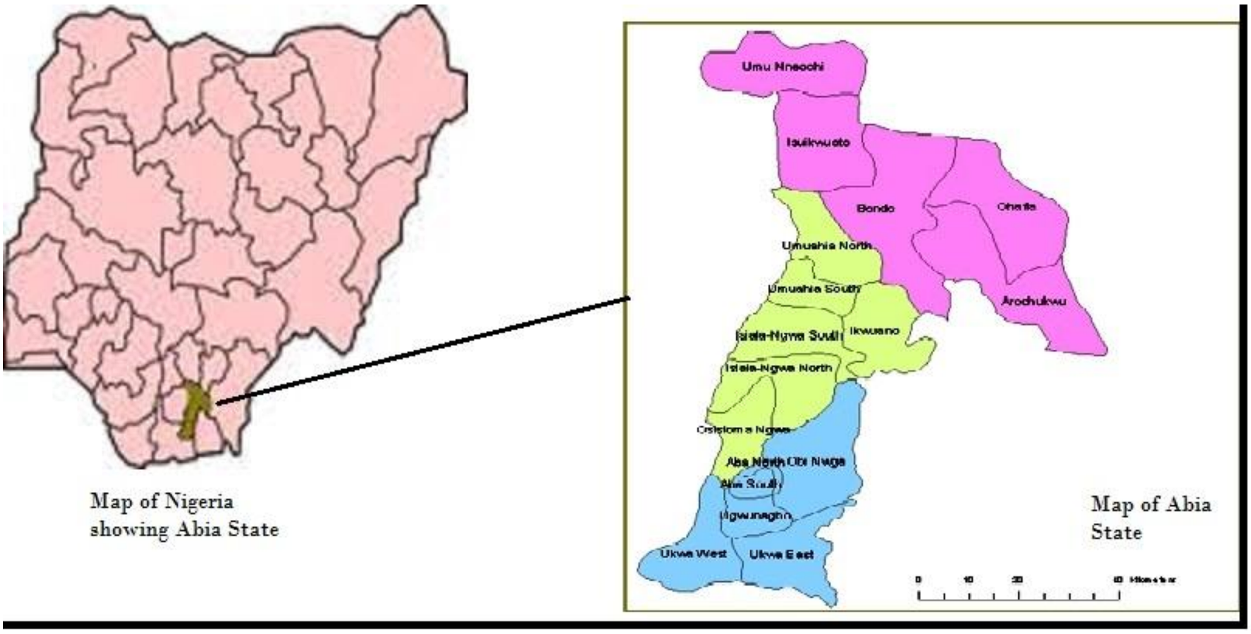
4) It can also be used to experiment with different inputs and parameters and examination of the impacts of constraints on why Morphology and growth patterns.

In this research, the model was applied to examine the impacts of location peculiarities on the location of rural infrastructures, in rural, Abia State Nigeria.

B. Study Location

Abia state is located in the southeastern region of Nigeria, lying approximately within Lat 4^{o} 40’ and 6^{o} 14’N and Long7^{o} 10’ and 8^{o}E. The state covers an area of about 6320sqKm which is approximately 5.8% the total land area of Nigeria (Ijeoma, 2000). The population stood at 2,845,380 in 206 but projected to 3,823,952 in 2016 at 3% natural growth rate. It has seventeen local Government Areas, shared into three senatorial zones namely: Abia North, Abia Central and Abia South, while umuahia is the state capital. Abia State falls within the sub equatorial climate zone with clearly marked dry season and double maxima rainfall in the June and September. Infact, rainfall begins in the month of march and ends in October (Ijeoma ,2000). The harmattan (Locally called Uguru) is noticed intermittently in December and intensely in January. Dry season commences from November to March. Within this period dry season water supply in the area is very severe and for this reason it is expected that reliance for water supply would be met by alternative sources like surface water bodies, private and public boreholes and water vendors. Mean monthly temperature is around 27^{o}c (Annual rainfall degree from 2200mm in the south to 1900mm in the north. Humidity is high reaching 90 percent in the rainy season. In Abia state, Ijeoma (200) identified nine major geological formations from south to north. These include; the Benin formation (or coastal plain sand); the Bende-Ameki group; the Nkporo shale group the Nsukka Formation (upper coal measures), the Eze-Azu shale group, and the Asu River group.



Location Map.

II. RESEARCH METHODOLOGY

The research was conducted in locations in isiala Ngwa North Local government area Abia state, Namely; Nbawsi, Umuezegu, Agburike and Umuomaiukwu. One hundred copies questionnaires were distributed in the area, (each of the communities receiving 25 copies), while 84 copies representing 84 percent were retrieved. Data retrieved from the field were subjected to evaluation using Monte Carlo simulation Technique and Chi square

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III. RESULTS AND DISCUSSION

To determine the underlying reasons technical the selection of Nbaswi as the site of the sitting public water supply scheme, saving the adjourning towns and communities, assumptions were generated which is in line with the mathematical sequentially of Monte Carlo simulation technique.

Generation of Assumptions

i) The location of public water scheme and Nbawsi was based on political motives.

ii) The locations of public water scheme at Nbaswi was based on population concentration

iii) The location of public water scheme was based on the centrality of Nbaswi to other benefiting towns and communities

iv) The location of public water scheme at Nbaswi was based on the presence of an existing reservoir.

Procedures in the use of Monte Carlo Technique

Given the theoretical bases of Monte carlo Techniques, the procedures evolved are as follows;

i) The formulation of a set of possible hypothesis on the factors governing the system of interest

ii) The construction of a matrix of probability from the theoretical considerations about the system of interest.

iii) The allocation procedure using both the probabilities matrix and a random number table

Stage 1 Point score matrix

Factors	1 Nbawsi	2 Umuezegu	3 Agburuike	4 Umuomaiukwu	Total
Presence of reservoir A	1	2	2	2	7
Distance Function B	5	1	1	2	9
Political Interest C	13	13	14	10	50
Population Distribution D	10	1	3	4	18
Total	29	17	20	18	84

The point score matrix represents the actual responses of respondents to the issue of defining the circumstances behind the selection of Nbaswi as the preferred location for sitting the water scheme

Stage II. Growth Probability matrix (A)

	1	2	3	4
A	1/84	2/84	2/84	2/84
B	1/84	2/84	2/84	2/84
C	5/84	1/84	1/84	10/84
D	10/84	1/84	3/84	4/84

Stage III Growth Probability Matrix (B)

	1	2	3	4	Mean Values
A	0.0119	0.0238	0.0238	0.0238	0.0208
B	0.0595	0.0119	0.0119	0.0238	0.0268
C	0.1548	0.1545	0.1667	0.1190	0.1488
D	0.1190	0.0119	0.0357	0.0476	0.0536

Stage III Eliminating the Decimals and Cumulative Addition of Scores

	1	2	3	4
A	119	+238	+238	+238
B	+595	+119	+119	+238
C	+1508	+1548	+1667	+1190
D	+1190	+119	+357	+476

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Stage IV Upward limiting numbers of a Random Number Field (RNF)

	1	2	3	4
A	119	357	595	833
B	1428	1547	1666	1904
C	3452	5000	6667	7857
D	9047	9166	9523	9999

Stage V the Random Number Field (RNF)

A	0000-0119	0120-0357	0358-0595	0596-0833
B	0834-1428	1429-1547	1548-1666	1667-1904
C	1905-3452	3453-5000	5001-6667	6668-7857
D	7858-9047	9047-9166	9167-9523	9524-9999

Stage VI tally table of Random Number Allocated

	1	2	3	4
A	II	III	III	IIII
B	III	I	IIII	III
C	IIII IIII IIII	IIII IIII IIII I	IIII IIII IIII III	IIII III
D	IIII IIII	I	III	IIII

Stage VII Final Simulated Result

	1	2	3	4
A	2	3	4	4
B	3	1	4	2
C	14	16	18	8
D	10	1	3	5

Stage VIII Testing Simulated Result against the observed using Chi Square

Point Score	Simulated E	O-E	(O-E)	(0-E)2/E
1	2	-1	1	0.50
2	3	-1	1	0.33
2	4	-2	4	1.00
2	4	-2	4	1.00
5	3	2	4	1.33
1	1	0	0	0
1	4	-3	9	2.25
2	2	0	0	0
13	14	-1	1	0.07
13	16	-3	9	0.56
14	18	-4	16	0.89
10	8	-2	4	0.50
10	10	0	0	0
1	1	0	0	0
3	3	0	0	0
4	5	-1	1	0.2
			$\sum$	8.63

Cal value =8.63
Tab value= 3.325e
95% confidence level

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
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The point score matrix was transformed into growth probability matrix. This was done by dividing the value of each cell by the sum total of all the cells. The result was further rearranged by eliminating the decimals and summed up cumulatively to produce the value of 9999 at the end. A random number field was created for each cell to enable tallying of the various times the scores in each cell appeared in the random number table. Nwachukwu V.O (2010). At the end, tally results yielded to simulated scores for each cell. Chi square was applied to other simulated results to obtain a test of significance. Nbaswi was formerly a regional administration center that served the northern ngwa community council and a major railway outpost. It possesses political leverage that helped to imitate and establishes political processes of regional strategic comparative existence. Population size may have increased likewise but the location did not offer any locational technical strategic importance. Presence of a 200,000 liters reservoir could have also provided added advantage rather it served little purpose.
Although, Agburike and Umuzegu were not more than 1KM distant from the area yet it was not technically enacted to supply water to all the catchment communities, rather water generation and distribution was mainly insitu, carrying the adjourning communities expected water supply. Marginalization of the water needs of these communities resulted to severe water scarcity, increasing cost of procuring water from alternative sources, vulnerability to diseases and illness which may be due to drinking water from unwholesome sources; early morning sickness resulting from early morning to go to nearby streams/rivers and private boreholes to fetch water and subsequent quarrels ensuring at the very few borehole taps morning in the area. In stage III growth probability matrix, political interest attracted the highest scores of 0.1548; 0.1548; 0.1667 and 0.1190. This possible given that the mean values for the options are as follows; presence of reservoir, 0.0208; distance function, 0.0268; political interest, 0.1488 and population distribution, 0.0536. Calculated result was higher than tabulated of 3.325 at 95% confidence.

IV. CONCLUSION

Morte carlo Simulation techniques is a Locational model very apt in defining locational equalities and inequalities that can enable an economic or social activity to be enhanced or reduced. In this case, political interest serial as the major for selecting the area as a choice for sitting of the public water scheme. Despite all other problems that may have contributed to the Operational inefficiency of the scheme, its choice of location created technical complexion that exhausted the ability of the water to the adjoining communities.

V. RECOMMENDATION

Our recommendation in this regard is to decentralize the existing water schemes and restricting their technically manageable units of fewer communities and that from the reception of project planning, execution, post execution to operational maintenance will be feasible given the socio-economic capabilities of communities. This method will help to reduce the cost and technical complexities of reticulating water over larger areas. It also makes community participation more meaningful hence each of the communities will only respond to the needs of water schemes sited in their areas.
Decentralization can be possible by providing lesser capacities of materiel borehole and receiving the water handspun technology would be a strategic way encouraging the growth of indigenous technology creating jobs, enhancing the welfare of those involved, generating revenue for the people and increasing the generation and supply potable water to the people.

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