



## MAPPING AND ASSESSMENT OF HYDROCARBON PIPELINE USING GIS (A CASE STUDY OF BAUCHI METROPOLIS)

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### **ABSTRACT**

*This paper is aimed at producing a map showing the built up areas in Bauchi metropolis that encroaches the hydrocarbon pipeline. The study was conducted due to insufficient information about the building line regulation of hydrocarbon pipeline within the study area. Spatial data was obtained using total station (Sokkia 600) and it was processed using ArcGIS 10.3 version. The features that violated the right of way setback along petroleum pipeline were ascertained using a proximity analysis. The finding reveals that 35% of the building along the pipeline violated the right of way while 65% maintained the right of way regulation. A composite map of the area showing the level of encroachment was produced.*

**Keywords:** ROW, pipeline, ArcGIS, map, hydrocarbon, proximity.

### **INTRODUCTION**

Right of Ways (ROW) is defined in different ways therefore have different meaning based on the context it served for be it for roads, traffic, pipeline, high tension, railway line, property law etc. It is define as a strip of land that is granted through an easement or other mechanism, for transportation, purposely for the maintenance and expansion of the existing service. Based on the context of property law, it is also defined as the right over someone's land and has the reasonable use and enjoyment of their property as long as it is not consistent with the owners use and enjoyment of the land. In general a right of way is a specific grant of land or an easement which is a right to pass across another land or it is describe as a right to travel unhindered, to access a route regardless of land ownership or any other legality. An easement is a certain right to use the real property of another without possessing it. Right of way is important because it protects properties from being damaged; protect the public from being harmed and to minimize any environmental consequences. This is necessary where ROW of harmful facilities like the hydrocarbon products that are being conveyed through pipelines. These restrictions associated hydrocarbon pipeline includes construction of boreholes, digging of wells, building of structures, bush burning. The specification based on hydrocarbon pipeline right of way ROW in Nigeria from available information indicated that the setback for NNPC hydrocarbon pipeline is 12.5m at both side of the pipeline making a total of 25m (Ministry of Land and Survey Bauchi). Right of way is not just applicable to hydrocarbon pipeline, but also to some utilities and facilities, that are either useful and harmful to human health, these may include industries, roads, communication most, underground sewage, buildings etc. These set back are required so as to help protect the community from the dangers associated with them and also to protect property. Set back in buildings are required so as to ensure that there is enough

open space within the house premises to afford enough privacy, ventilation and also to achieve a balanced land use pattern (ABUBAKAR,2021). The purpose and function of setback are toward off encroachment by other potentially infamous land use development on the pipeline right of way and its ancillary installation and facilities protecting them from potential human and environmental damages. (kepas, 2017).

A type of hazard zone for a natural gas pipeline could be based on generalized distance from given receptors that could be harm by pipeline failure. such distance area were categorized depending on the population size of 200m, facilities like schools, rehabilitation, duties etc has a distance of 242.4m and pipe with diameter greater than 0.75m and pressure greater than 1000pcy has a distance of 303m and lastly area of public assembly like religion worship area city square, market etc. Oil pipelines are required to be given a right of way setback of 25m wide, specifically required by the federal government for security and safety reasons. The pipelines are required to be buried about one meter beneath the surface along a 25 meter wide right of way specifically acquired by the federal government for security and safety reasons (Abubakar et al 2021). These conditions are applicable in most part of the world, for example England, United State of America etc. Written agreements, or easements, between land owners and pipeline companies allow pipeline companies to construction and maintain pipeline right of many across privately owned property. Most pipelines are buried below ground in the right of way. The land uses along the right of way are 50 feet wide, but may be wider or narrower in specific locations (Muhlbauer, 2014). This right of way is kept clear to allow the pipeline to be safety operated, aerially surveyed and properly maintained. Pipeline companies are responsible for maintaining their right of way to protect the public and environment and the line itself and other customers from cost of service. Pipeline right of way is located in urban, suburban and rural communities. Permanent markers are located at roads, railways and other intervals along the ROW, these shows the approximate depth and location of the buried pipeline (Api, 2018)

## **STUDY AREA**

The study area is located at Bauchi covering from Anguwan Kanawa to inkil Village in Bauchi metropolis. The hydrocarbon pipeline covers a distance of 20.943km and its geographically located on 583408.472E, 1134016.366N and 588387.301E, 1135308.727N coordinates north of the equator.

## **METHODOLOGY**

The methodology adopted for study was Geospatial information system techniques through the following procedure:

## **DATA ACQUISITION**

The spatial data was acquired using Total station (Sokkia 600) instrument and imagery was downloaded using remote sensing software.

## **DATA PROCESSING**

The obtained field data was processed using ArcGIS 10.3 version was use to plot the survey using Co-ordinate geometry (COGO), the imagery was geo-reference and digitized. The hydrocarbon pipeline was buffered.

**RESULT AND ANALYSIS**

Table 1: Pipeline distance and area encroached from the ROW Source (authors field observation)

<b>Building ID</b>	<b>Encroached Row Distance (M)</b>	<b>Encroached Area (M<sup>2</sup>)</b>
1	1.507	38.783
2	0.601	10.021
3	0.899	14.031
4	0.474	12.612
5	0.271	9.868
6	1.665	11.077
7	1.131	10.165
8	2.064	11.318
9	1.131	11.566
10	2.064	14.763
11	3.391	32.436
12	1.131	3.126
13	1.358	3.599
14	2.754	13.665
15	1.237	14.214
16	3.391	14.529
17	1.131	14.816
18	1.358	15.117
19	2.754	15.340
20	1.214	15.779
21	2.301	17.888
22	2.318	28.323
23	2.743	28.973
24	1.214	10.169
25	1.301	12.255
26	1.318	10.319
27	0.743	10.352
28	1.234	14.157
29	2.214	29.339
30	2.301	14.765
31	2.318	14.792
32	0.743	14.825
33	1.214	14.943
34	2.126	15.167
35	4.426	15.412
36	5.386	15.023
37	0.900	10.322

38	0.323	10.023
39	0.445	10.21
40	0.021	13.507
41	0.031	13.601
42	0.033	14.157
43	0.524	21.354
44	0.424	14.825
45	0.612	13.899
46	0.855	16.474
47	1.077	12.771
48	1.777	14.223
49	1.165	13.665
50	1.318	14.426
51	0.355	0.824
52	1.340	14.588
53	1.373	17.296
54	1.566	13.541
55	1.763	14.131
56	2.436	25.064
57	2.879	4.883
58	2.899	10.438
59	3.126	36.391
60	3.559	39.370
61	3.599	23.182
62	3.665	15.162
63	4.214	15.358
64	4.214	5.466
65	4.381	7.337
66	4.529	23.754
67	4.816	12.237
68	4.883	2.899
69	0.070	0.201
70	5.180	8.887
71	0.551	10.101
72	5.466	4.214
73	5.779	15.162
74	2.373	14.381
75	7.333	24.927
76	7.888	30.023
77	8.323	12.214

78	8.887	5.180
79	8.872	12.083
80	8.934	22.301
81	8.273	10.169
82	10.694	29.318
83	10.169	28.973
84	10.255	29.743
85	10.319	28.335
86	10.352	30.023
87	0.438	2.899
88	11.955	26.490
89	12.083	28.887
90	12.469	29.558
91	12.738	26.759
92	12.153	29.339
93	11.157	30.003
94	1.177	14.327
95	2.323	14.060
96	2.227	14.157
97	2.324	14.765
98	1.588	10.354
99	1.765	14.060
100	1.752	14.327
101	0.825	9.842
102	0.251	10.352
103	1.525	12.242
104	1.256	9.492
105	1.355	8.427
106	2.425	8.452
107	5.895	29.136
108	5.944	25.440
109	6.759	13.738
110	0.886	1.077
111	0.120	2.119
112	7.296	1.373
113	7.303	25.694
114	9.730	37.908
115	1.899	22.893
116	2.499	11.955
117	2.409	27.061

118	0.123	2.795
119	0.664	10.277
120	2.893	21.899
121	3.182	3.599
122	2.927	7.337
123	5.440	15.944
124	5.694	17.303
125	7.061	22.490
126	7.116	34.602
127	7.953	34.602
128	7.573	47.808
129	9.136	15.895
130	9.558	13.469
131	1.607	34.602
132	1.949	43.054
133	3.3090	42.211
134	3.602	27.953
135	4.602	31.607
136	3.325	36.120
137	6.120	35.325
138	6.952	42.111
139	7.908	19.730
140	3.972	40.673
141	0.673	39.972
142	1.316	50.579
143	4.111	33.309
144	2.508	36.952
145	4.054	31.949
146	4.575	45.694
147	4.694	44.575
148	4.808	27.953
149	5.579	41.316
150	5.579	60.903
151	2.741	64.331
152	6.903	50.579
153	6.331	52.741
154	7.422	100.126
155	8.116	101.980
156	10.126	76.422
157	10.930	80.116

158	10.930	105.412
159	10.412	101.930



Figure 1: Spatial query showing properties that encroached pipeline at Rafin zurfi area



Figure 2: Spatial query showing properties that encroached pipeline at kusu area of yelwa

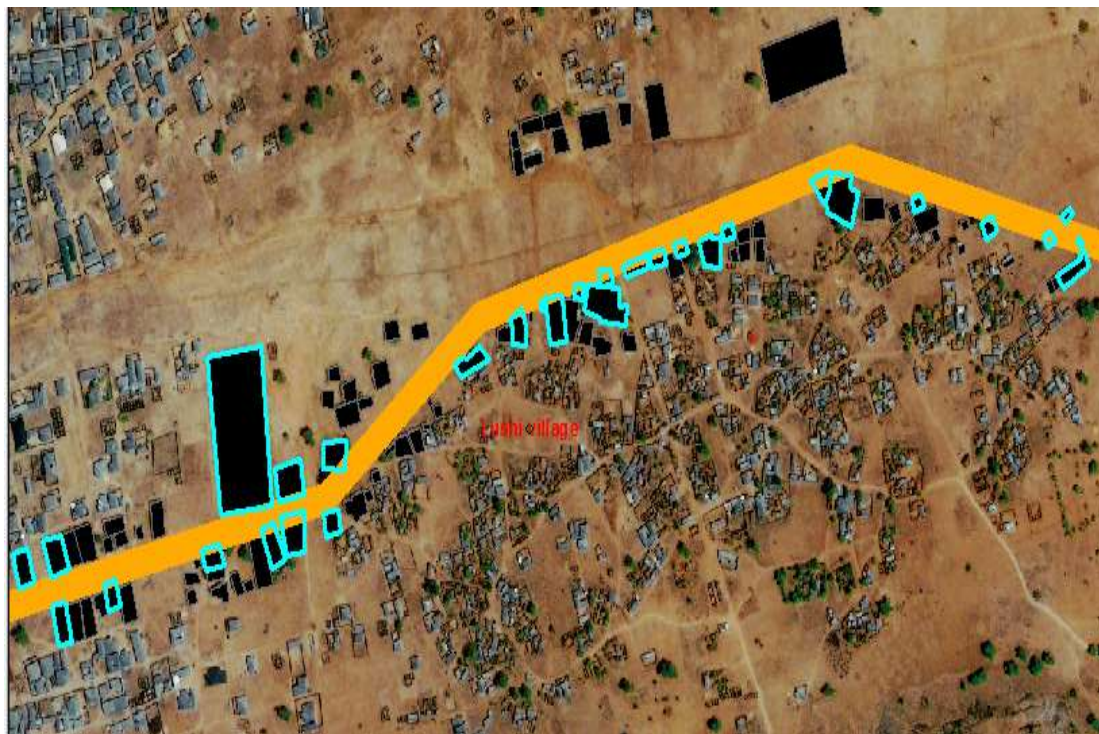


Figure 3: Spatial query showing properties that encroached pipeline at Lushi village

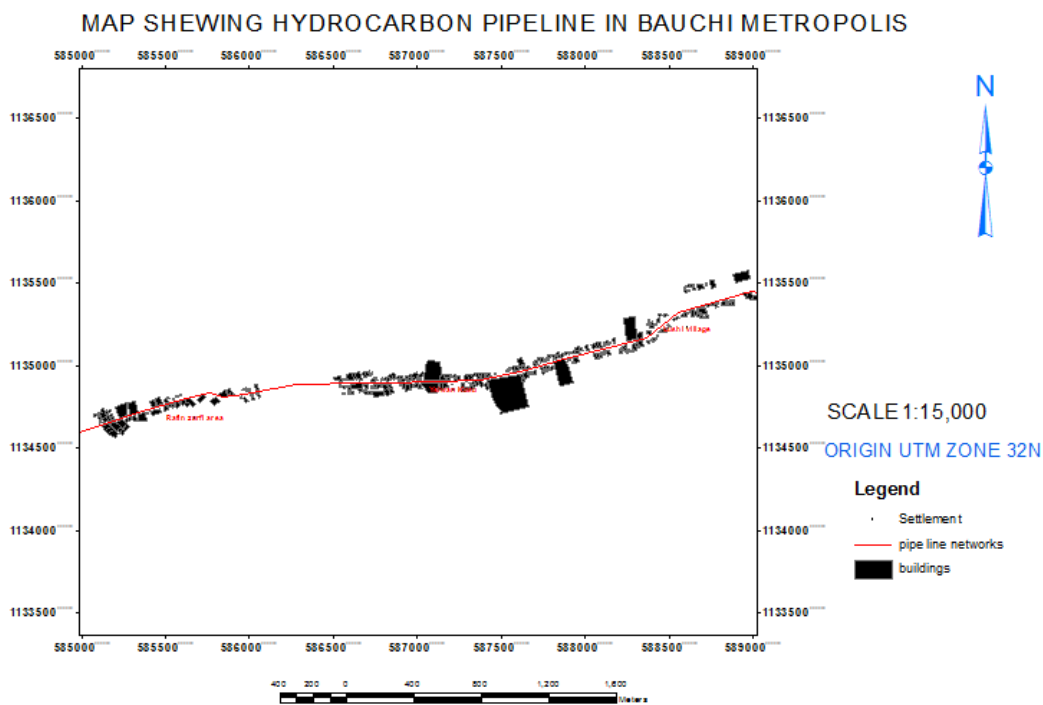


Figure 4: composite map showing hydrocarbon pipeline and Buildings



## Level of encroachment

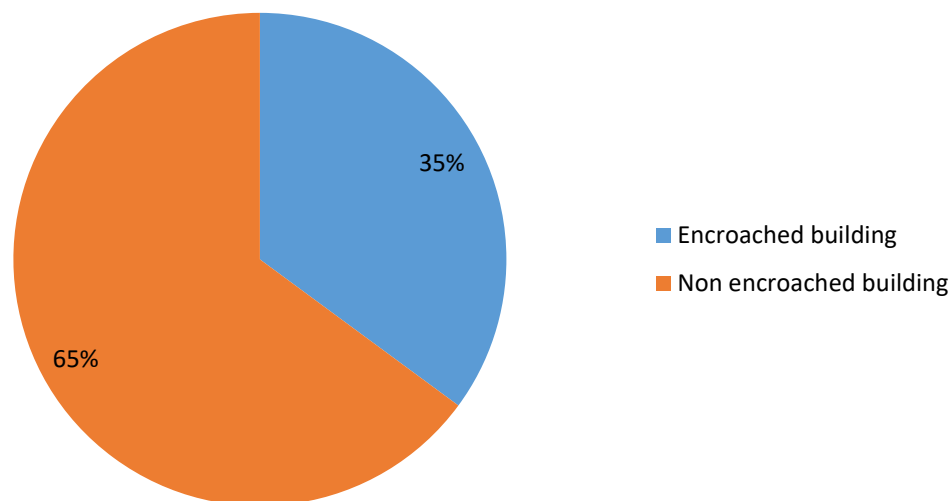


Figure 5: pie chart showing level of encroachment building to ROW

### DISCUSSION OF RESULT

Table 1: is result showing 159 building that violated the right of setback with encroached distance and total area to Pipeline along the corridor of the right of way. Figure 1: is a spatial query showing 39 properties that encroached pipeline at Rafin zurfi area as verge in blue. Figure 2: Shows a spatial query 56 properties that encroached pipeline at kusu area of yelwa as verge in blue. Figure 3: Shows spatial query 29 properties that encroached pipeline at Lushi village as verge in blue. Figure 4: is composite map showing hydrocarbon pipeline in red color and Buildings in black color along the right of way. On the map, a total of 453 building were located out of which 159 violated the right of way while 294 maintained the right of way regulation. Figure 5: is a pie chart showing the level of encroachment to ROW. On it 35% of the building violated the right of way while 65% maintained the right of way regulation.

### Findings

The finding reveals that level of encroachment into the right of way was found to be 35% this shows that quick measures has to be taken to stop people violation of setback rule. If adequate measures are taken, it will keep on increasing gradually and reach a stage that cannot be control easily.

### SUMMARY

These study provided a map of right of way (ROW) of NNPC hydrocarbon pipeline, the spatial data was obtained using a total station The data was processed in a computer using ArcGIS 10.3 GIS application

software's package to produce a composite map that serve as a means to know the extent of encroachment into the study area.

### **RECOMMENDATION**

The research recommends that measures should be put in place Government to safeguard the areas by demarcating the extent of ROW on ground which can prevent destruction or damages or residential buildings from encroachment. And also enlighten the general public about risk and implication of encroaching ROW via media and sensitization program.

### **CONCLUSION**

A composite map showing hydrocarbon pipeline and the buildings that violate the setback right of way regulations which is the aim of the research was produced. The study was successfully achieved through the use of GIS techniques which make the production of map easier and faster.

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