XXVII FIG CONGRESS
11–15 SEPTEMBER 2022
Warsaw, Poland
Volunteering for the future – Geospatial excellence for a better living

Quality Analysis of OpenStreetMap and Digital Elevation Data Based North-Western Nigeria (11646)

Samuel Sule GARBA, Hassan MUSA, Shuaibu BALA, Hafiz NA'İYA and Muhammad MUSTAPHA-Nigeria

ORGANISED BY FIG SGP
PLATINUM SPONSORS esri THE SCIENCE OF WHERE Trimble.

PRESENTATION OUTLINE

- Introduction
- Materials and Methods
- Results And Discussion
- Conclusion

Introduction

▪ Open Source geospatial data is an easily accessible data available to the public without any restrictions.

▪ OpenStreetMap, OSM project is a part of Open Source Project. Its aim is to create a free digital map of the whole world through the engagement of participants across the glove

▪ The information is collected, collated on a central database and distributed in digital form

▪ A Digital Elevation Model (DEM) is a representation of the bare ground surface in 3D without any objects and value of pixel is equal to heights.

- Open source geospatial information cannot be without error due to area coverage, data collectors and mode of collection. This study intends to use reference data to analyse the quality of OSM and DEM of Katsina town and sunshine quarry site

Introduction

- Open Source geospatial data is an easily accessible data available to the public without any restrictions.
- OpenStreetMap, OSM project is a part of Open Source Project. Its aim is to create a free digital map of the whole world through the engagement of participants across the glove
- The information is collected, collated on a central database and distributed in digital form
- A Digital Elevation Model (DEM) is a representation of the bare ground surface in 3D without any objects and value of pixel is equal to heights.
- Open source geospatial information cannot be without error due to area coverage, data collectors and mode of collection. This study intends to use reference data to analyse the quality of OSM and DEM of Katsina town and sunshine quarry site

MATERIALS AND METHODS

- **Materials**
- ***Software used and the application***
  - ArcGIS version 10.4.1 for data pre-processing and analysis
  - GPS Visualizer for the extraction of SRTM coordinates and heights
  - SPSS for statistical analysis

- ***Data used***
  - SRTM Digital elevation of sunshine quarry site
  - OSM and Street guide of Katsina Local Government Area
  - 0.6 meters resolution image of Katsina metropolis
  - GPS coordinates of sampled locations in sunshine quarry site

Materials and Methods

- **Methods**
  Data Pre-processing
- OSM was converted to shapefiles file extension.
- The extend of the study area was clipped.
- The data was projected from GCS to WGS84 Zone 32N.
- The street guide of the study area was scanned, georeferenced & vectorised
- Street guide was buffered (6 meters buffer zone)

Materials and Methods

Methods

- **Analysis of OSM**
- The total length of all selected roads on both maps were computed using ArcGIS attribute table tools and the length compared.
- Intersection analysis was carried out between 6 meters buffer zone and OSM roads.
- Identity tool was used to check the attribute information of both the maps to compliance.
- Classification of roads to were analyse using ArcGIS identity tool.
- Finally, topology was analyse

Materials and Methods

Methods

Analysis of SRTM Digital elevation

- GPS coordinates were converted to KMZ file extension using ArcGIS software.
- The KMZ file, was uploaded to GPS visualizer online utility.
- The coordinates and heights of the corresponding GPS positions were extracted by the visualizer and download.
- GeodEval online calculator was used to compute the Geod heights (EGM96) of each position and converted the same to ellipsoidal heights
- Descriptive Statistic of the heights were computed and compared. Scatter plots of both the GPS and DEM heights were drawn. Relationship between the heights was analyse using correlation in SPSS application

Results and Discussion

Plate 1 Overlaid OSM and Image of the area depicting OSM shift from the center

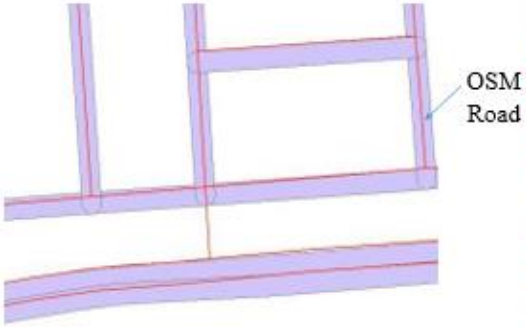

Figure 2 Overlaid OSM and 6 meters bufferzone

Plate 2 overlaid satelite image of the study area and OSM depicting completeness

Figure 3 Result of topological analysis depicting point errors

Table 1 Correlation between DEM AND GPS Heights

		DEM Heights	GPS Heights
DEM Heights	Pearson Correlation	1	.908**
	Sig. (2-tailed)		<.001
	N	23	23
GPS Heights	Pearson Correlation	.908**	1
	Sig. (2-tailed)	<.001	
	N	23	23

**. Correlation is significant at the 0.01 level (2-tailed).

Table 2 Descriptive statistics SRTM and GPS Heights

Table 2 Descriptive statistics SRTM and GPS Heights

		DEM Heights	GPS Heights
N	Valid	23	23
	Missing	0	0
Mean		651.237783	720.4983
Std. Error of Mean		1.3766396	1.76116
Median		651.143000	719.9333
Mode		640.3080	706.04
Std. Deviation		6.6021314	8.44621
Variance		43.588	71.338
Skewness		0.235	0.205
Std. Error of Skewness		0.481	0.481
Kurtosis		-0.910	-0.813
Std. Error of Kurtosis		0.935	0.935
Range		23.3640	30.79
Minimum		640.3080	706.04
Maximum		663.6720	736.83
Sum		14978.4690	16571.46
Confidence level		0.793	0.961

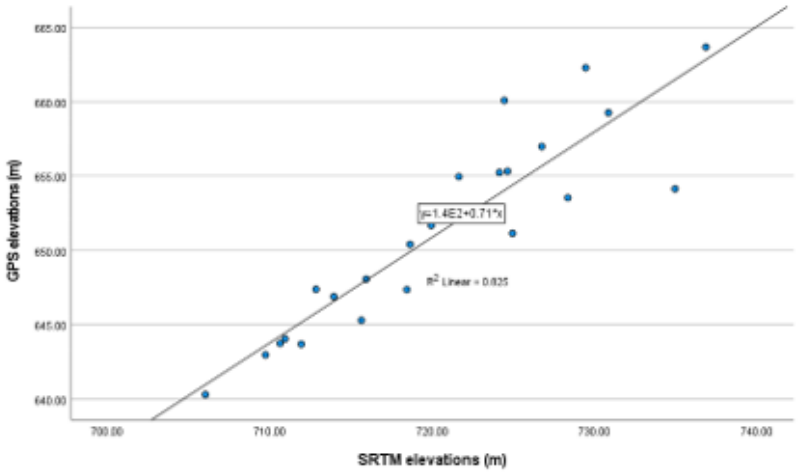

Figure 4 Scattered plot for SRTM and GPS heights

Attribute tables

Table 3 Attribute table of Street guide complete attribute

Table

Street guide of Katsina Metropolis

FID	Shape *	Id	Distance	Code	Type
0	Polyline	0	9390.24	1	Ibrahim Shehu Shema Way
1	Polyline	0	7932.27	1	Aminu Bello Masari Way
2	Polyline	0	4722.89	1	Abu Gidado Way
3	Polyline	0	3908.48	1	Abba Musa Rimi Way
4	Polyline	0	1783.94	1	Lawal Kaita Way
5	Polyline	0	2121.6	1	Saidu Barda Way
6	Polyline	0	2911.7	1	Umaru Musa Yar' adua Way
7	Polyline	0	1795.97	1	Aminu Zayyad Crescent
8	Polyline	0	2900.37	2	Murtala Muhd Way
9	Polyline	0	1697.95	2	Yahaya Madaki Road

1 (0 out of 581 Selected)

Table 4 Attribute table of OpenStreetMap with incomplete attributes

Table

OpenStreetMap of Katsina metropolis

FID	Shape *	osm_id	code	fclass	name
58	Polyline	213163419	5114	secondary	Kaita Road
59	Polyline	213163420	5115	tertiary	
60	Polyline	213163421	5115	tertiary	
61	Polyline	213163422	5114	secondary	
62	Polyline	213163423	5114	secondary	
63	Polyline	213163424	5114	secondary	
64	Polyline	213163425	5115	tertiary	
65	Polyline	213163426	5114	secondary	
66	Polyline	213163429	5114	secondary	
67	Polyline	213163430	5121	unclassified	

1 (0 out of 6323 Selected)

Table 5 Attribute table of street guide showing current attribute

Table

OpenStreetMap of Katsina metropolis.

FID	Shape *	Id	Distance	Code	Name
0	Polyline	0	9390.24	1	Ibrahim Shehu Shema Way
1	Polyline	0	7932.27	1	Aminu Bello Masari Way
2	Polyline	0	4722.89	1	Abu Gidado Way
3	Polyline	0	3908.48	1	Abba Musa Rimi Way
4	Polyline	0	1783.94	1	Lawal Kaita Way
5	Polyline	0	2121.6	1	Saidu Barda Way
6	Polyline	0	2911.7	1	Umaru Musa Yar' adua Way
7	Polyline	0	1795.97	1	Aminu Zayyad Crescent
8	Polyline	0	2900.37	2	Murtala Muhd Way

1 (0 out of 581 Selected)

Table 6 Attribute table of OpenStreetMap with previous name

Table

features

osm_id	code	fclass	name	ref	oneway	maxs
213163368	5113	primary			F	
213163369	5113	primary			F	
213163370	5113	primary			F	
213163371	5113	primary	Ring Road		F	
213163372	5113	primary	Ring Road		F	
213163373	5113	primary	Ring Road		F	
213163374	5113	primary	Ring Road		F	
213163375	5115	tertiary			F	

0 (0 out of 6323 Selected)

Results and Discussion

•*Positional accuracy* – From figure 2 and plate 1 the result of the analysis of positional accuracy reveals the roads are within 6 meters butter zones around the digitized roads from the street guide map. The average shift distance is 3 meters.

•*Completeness* –The total length of Trunk, Primary, Secondary and Tertiary roads (see plate 2) on both the street guide and OSM are the same (319624 meters)

•Logical consistency – Analysis of connectivity (on figure 3) among the roads revealed 447 dangle (disconnection) and 7551 intersections and 0 overlap

•*Attribute accuracy* – Comparison between OSM and street guide of Katsina metropolis in terms of attribute or name of the roads shows only 37 out of 140 roads on OSM were named (see table 3 and 4).

•*Temporal quality* – the rate at which the database and geometrical information change with time is very slow. These changes were not shown on the map as shown on figure 5 and 6.

Results and Discussion

- The results of the closeness of SRTM Digital elevation and GPS heights is presented in Table 1, 2 and Figure 4. From table 1 the accuracy of SRTM compared with GPS is about 90.8%. also figure 4 depicted the graph of GPS and SRTM heights, from the graph the relationship two heights are is very strong (R^2 Linear = 0.825). The standard deviation and standard error of both SRTM and GPS on table are closer.

- $GPS_{reading} = 0.71DEM_{SRTM} + 1400$
- Is the relationship between SRTM DEM and GPS Coordinates

Conclusion

- OpenStreetMap has a general shift of 3 meters, its 100% complete, only 26% of the OSM in Katsina metropolis were identified labelled and it has no topology. OSM is good for street guide mapping of an area. It cannot be used for geodetic network analysis as there is no connectivity among the nodes and edges of the roads. The correlation between SRTM and GPS heights is 90.8%. Descriptive statistics indicate the standard deviation, standard error and confidence measure of SRTM is closer to GPS heights. SRTM is suitable for terrain analysis of large area and preliminary design of engineering structures. This study recommends quality analysis of each open source data before use