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PROFESSIONAL APPROACH TOWARD THE CREATION OF SPATIAL LOCATION WEB MAP: A VIEW OF KENULE BEESON SARO - WIWA POLYTECHNIC, BORI

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Abstract: *Web Maps are online maps created with the help of GIS (Geographic Information Systems) applications that provide a way to work and interact with geographic content organized as layers. This paper aims at creating and hosting a Web Map of Kenule Beeson Saro-Wiwa Polytechnic, Bori with emphases on Engineering Campus of the Institution. This project involves various geographic information system operations, such as Google earth image extraction in decimal degree (latitude and longitude), conversion of the coordinates to Minna Zone 32, georeferencing the google image, digitizing to different layers such as buildings as points, the boundary, buildings as polygon , internal roads and footpaths as line, geotagged and ungeotagged photos are hyperlinked to building points having the following attributes, features serial number, names, functions, type of building, default path, relative path, codes, image path, Easting and Northing coordinates, and the date of data collection using two Google base maps (namely; Google Satellite and Google Terrain Hybrid Maps) and creating the web map through Qgis2web plugin. Hosting the web map was done in Github website with the main purpose of making geographical data more accessible, understandable, and useful for various purposes. The maps can be accessed using these links. https://enyinmaunlimited.github.io./Ken-Poly-Web-Map-Survey-Dept./*

https://francis2161.github.io/KenPoly/ https://enyinmaunlimited.github.io/KenPolyWapMap/

INTRODUCTION

Web Maps are online maps created with the help of GIS (Geographic Information Systems) applications that provide a way to work and interact with geographic content organized as layers. It can also be called web mapping or an online mapping.

A web mapping or an online mapping is the process of using the maps delivered by Geographic Information Systems (GIS) on the internet, more specifically in the World Wide Web (www), to view, analyze or share a visual representation of geospatial data in map form.

It provides the ability to access geospatial mapping on the internet through a web browser interface. It is often time referred to as web GIS (Geographic Information System). It creates data visualization, which is increasingly been used to empower organizations to derive geospatial insights across the enterprise. These mapping systems play a key role in the proliferation of

location intelligence accessible to various classes of individuals. This sort for information about places and organizations can be accessed, updated, and visualized anywhere and at any time, using any desktop, website, tablet or mobile device.

Historically, in 2001, the classification was done by Kraak. He distinguished static and dynamic web maps and further distinguished interactive and view only web maps. Presently there are increased numbers of dynamic web maps types using or from static web map sources.

Dynamic Web Maps Types

- **Analytical Web Maps:** That has to do with Geographic Information System (GIS) analysis, of ambiguous geodata sets that needs updates. The web clients gain capabilities "processing is distributed", because port of the analysis can be carried out by the GIS geodata serves.
- **Animated and Real-time:** Web maps real-time these shows situational phenomenon that are in close to real-time (only a few seconds or minutes differences). Data is collected by sensors and the maps are generated or updated at regular interval or on demand.

Animated maps show changes on the map over time by animating one of the graphical or temporal variables. There web maps with real-time animation includes weather maps, traffic congestion maps and vehicle monitoring systems Twitter uses this map system to reflect on how users reacted to news and events worldwide.

Collaborative web maps:

They are a developing potential maps where users collaborate to create and improve the web mapping experience. Some of these maps are:

- WikMapia
- Open street map
- Here map creator
- Google map maker

Online Atlases

The traditional atlas, gains some remarkable visual presentation, transformation and large transition when hosted on the web. Some are also often raw data downloads and georeferenced accurately.

Static Web Maps

These are WebPages that are viewed without animation or interactivity. These files are created once through any GIS applications and updated at will of the creator. There are various graphical formats of static web map, according to the type of data set used.

Raster data sets (files) are JPEG, PNG, GIF and TIFF.

While vector data (files) are SVG, PDF or SWF.

Web map scan be created using current GIS major applications namely

- Quantum Geographical Information Systems (QGIS).
- Aeronautical Reconnaissance Coverage Geographic Information System (ArcGIS)

Knowledge of the HTML language is a most in creating web maps especially when images and videos are involved

STATEMENT OF PROBLEM

In an attempt to provide information system that is globally accessible and appreciated. As the dream of a global village is nearly being achieved and analogue information systems are gradually been eradicated completely. Having a digital information of Kenule Beeson Saro-Wiwa Polytechnic, Bori by the surveying and Geo-informatics department that can be globally recognized and people having a holistic knowledge of the school

AIM OF PROJECT

The aim of this project is to produce and host a Web Map of Engineering Campus of Kenule Beeson Saro-Wiwa Polytechnic, Bori, Rivers State.

THE PURPOSE OF A WEB MAP IS TO:

1. Visualize geographic data: Display data associated with specific locations or areas on a map.
2. Facilitate navigation: Provide directions, routes, and locations to help users navigate.
3. Enhance decision-making: Offer insights and analysis of geographic data to inform decisions.
4. Improve communication: Effectively convey complex information through interactive maps.
5. Support research and analysis: Enable researchers to analyze and visualize geographic data.
6. Provide location-based services: Offer services like nearby searches, location tracking, and georefrencing.
7. Enhance user experience: Add interactive and engaging maps to websites and applications.
8. Support urban planning and development: Help urban planners and developers visualize and analyze data.
9. Facilitate emergency response: Provide critical location information during emerge Promote exploration and discovery: Encourage users to explore and discover new places and information.

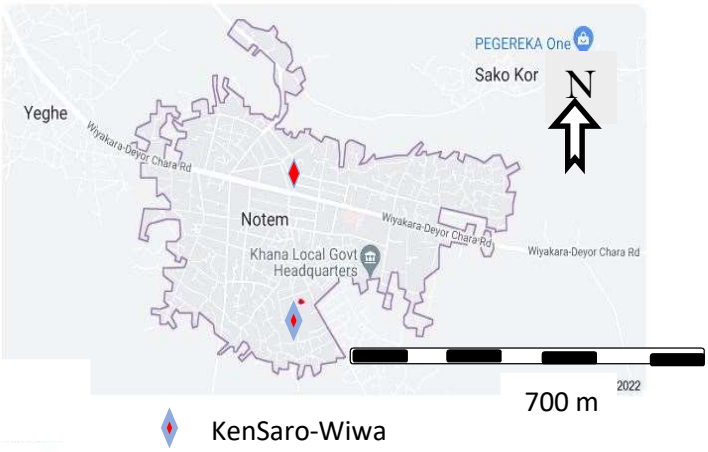
Overall, web maps aim to make geographic data more accessible, understandable, and useful for various purposes.

SIGNIFICANCE OF THE STUDY

1) To produce and provide location intelligence (information) of the polytechnic.
2) Through the hyperlinked photographs the beauty of the school can be accessed by individuals without coming down to school physically.
3) A good tool for advertising the school.
4) To explore, analysis, synthesis and present the school in an easy and understandable manner.

5) Accurate measurement can be taken within the map.
6) It gives an edge to the department of Surveying and Geo-informatics over other Survey departments in other institutions. By producing a web map of this institution, we can obtain donations from government agencies and professional bodies.

STUDY AREA MAP OF NOTEM COMMUNITY



Degree minutes seconds

Easting: 7°22'16.8" E

Northing: 4°40'06.5" N

Decimal Degree

7.371335 E

4.668469 N

Universal Transverse Mercator

319343.4478 E

516226.5652 N

Current Map Placemark Point: Easting: 319198.02 mE, Northing: 516196.52 mN

DEFINITION OF BASIC TERMS

Map: (Cartography) a hand-drawn or printed document describing the spatial distribution of geographical features in terms of a recognizable and agreed symbolism.

Digital: The collection of digital information about the part of the earth's surface.

Database: A collection of interrelated set stored together and controlled by a specific schema. A content and specified set of procedures is used in adding data to a database and in changing or retrieving existing data from a database.

Spatial: Refers to phenomena distributed in two or three dimensional space and therefore having physical dimensions.

Vector Object: A data structure for representing point and line data by means of 2 – or – 3 – dimensional geometric (Cartesian x,y, or x,y,z) coordinators.

Point: A level of spatial measurement referring to an object that has no dimension. Examples are walls, navigational lights etc.

Line: A level of spatial measurement referring to a one-dimensional defined object having a length and direction and connecting at least two points. Examples are roads, railroads, telecommunication lines, and stream.

Polygon: A two-dimensional figure with three or more sides intersecting at a like number of points. In GIS system an area.

Attribute: A set or collection of data that describe the characteristics of that world entities or condition. They are usually alphanumeric, (names or codes)

Raster Object: A raster is a data structure (logically a 2-dimension array) that contains rows and columns of numbers of a single data type. Each number represents the value of some parameter (like elevation or red spectral intensity). Each number (or cell value) is often use to control the colour and intensity of one pixel on a computer display screen.

Geo-reference System: An (x,y) or (x,y,z) coordinates system that locates points on the surface of the earth as a reference to points on a mal. System include latitude-longitude, Universal Transverse Mercator, and state plane coordinates.

Latitude: The angular distance on degree of a point on the earth east or west of the Primes Meridian.

Buffer: A portion of computer memory set aside for quick temporary storage. A buffer is commonly used to store data on its way to or from a hardware device such as disk drive. The buffer lets the computer save up access operation and not be slowed down by waiting on the hardware to respond at every step.

Cartography: The art or science of making maps.

Control Point: (Ground control point) are points which are used to establish map coordinate control for un-georeferenced objects or images. In the manual mosaic process, a control points is a feature in a piece of the mosaic (such as a road intersection) for which map coordinates are known. In the raster – to – vector calibration process, a control point is a feature that is collocated between the un-georeferenced raster object, and the calibrated vector object overlay. A control point may be something like a bend in a river or road intersection that shows on both a raster object and overlying vector object.

Coordinate Systems: A particular kind of reference frame or system, such as plane rectangular coordinates or spherical coordinates, which use linear or angular quantities to designate the position of points (features) within that particular reference system.

Data: Things know about real world entities: results of observations or measurements of such features. A single datum has three potential components; attribute information that describes the substance, characteristics, variables, values and similar qualities of the datum; geographical information that describes the position of the datum in space relative to other data, and temporal information that describes the instant or period of time for which the datum is valid.

Data Type: (map layer) the name of a data set based on the nature of the real world entities or conditions described by the data e.g. forest stand data, soil type data, campsite location data, habitat type data, insect damage map, boundary lines, road etc. when the data are represented and stored on maps the term map layer is synonymous with data type.

Element: A vector object is made up of three different classes of elements.

1. Nodes; which are single coordinate pairs (or triplets) that define a point (such as a spring
2. Lines; which are curvilinear strings of coordinates which define a curved line (such as stream) and
3. Polygon; which are collections of lines which inscribe an area (such as lakes etc.)

Image: Any analog or digital two-dimensional array of values whose spatial inter connections convey useful information. A photographic print is an image but an image is not necessarily a photograph.

Map projection: A device for representing all or part of a rounded surface on a flat sheet. Since this cannot be done without distortion, the cartographer must choose the map characteristic (area, shape, scale, direction) which is to be shown accurately at the expense of the others. The map projection geometrically or mathematically generates the grid of lines of latitude and longitude.

Popup: information or a set of choices that appears. On the text screen when a function key is pressed. Popup provide access to temporary and lateral processes. Such a making a quick measurement from the screen. After a popup process is finished the system returns to the same states and location as when the popup was invoked.

TIFF: Tagged image file format

Universal Transverse Mercator (UTM) Map Projection: A system of plane coordinates based upon 60 north-south trending zones, each 6 degree of longitude wide that circle the globe.

PROJECT DESIGN AND METHODOLOGY

PLANNING

Planning was done in the following sequence. 1. Reconnaissance 2. Google earth image extraction 3. Geo-referencing 4. Digitizing 5. Table creation 6. Acquisition of geotagged and ungeotagged photographs. 7. Hyperlinking 8. Web Map Creation. 9. Hosting (creating a web link)

EQUIPMENT EMPLOYED (USED)

The following are the equipment used under the various categories

1. **Hardware:** Field book and pen; Flash drive ; Laptop computer; Mouse; Phone camera (for taking geotagged photo and internet connection)
2. **Software:** Google Earth Pro; QGIS 3.22; Microsoft Excel ; Microsoft Word; Note Pad.; Google Chrome; Snipping Tool; GPS Map Camera application ; Non Metric Camera; Edit Pad; Sublime Text Editor

GOOGLE EARTH IMAGE EXTRACTION

1. Launch the Google Earth Pro application; 2. Type in the name of the location. “Ken SaroWiwa Polytechnic, Bori; 3. Click the “Search button; 4. The “search” “Ken SaroWiwa Polytechnic Bori Nigeria.; 5 The search result “Ken Saro-wiwa Polytechnic 502101, Bori, (kenpoly.edu.ng); Click on “Tools” and under it, click on “Option” the dialogue box will

appear.; 6. Set the Unit of Measurement to “Meters, Kilometers”. 7. Click on “Apply” and “OK” the dialogue will disappear. 8. Click on the “Placemark” icon, another drop down menu will pop up with the icon on the map, move to the desire location; 9. Input the name of the location; 10 Copy the coordinates to note pad;
11 Click on “View”, select “Reset” and Tilt and Compass. The map will accurately orient itself;
12 Click on the “File”, “Save”--- Save Image”.

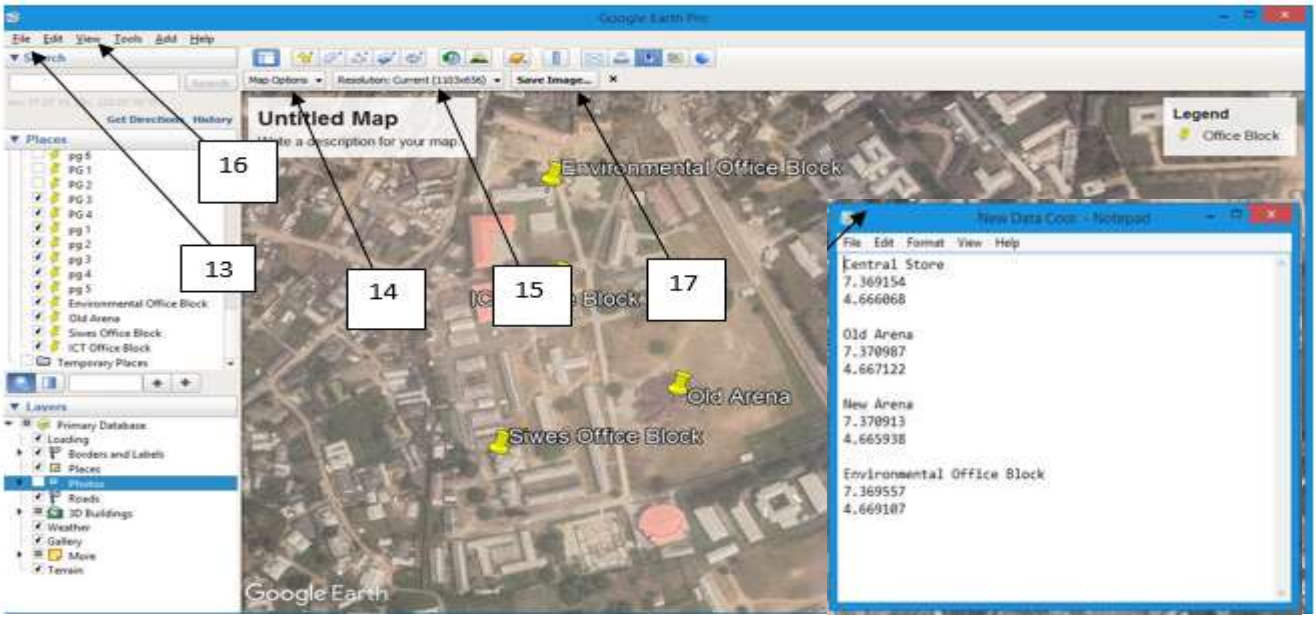


Fig.3.1. Showing the “New Placemark” in yellow and coordinates in note pad

GEO-REFERENCING

This is the process of aligning points on imagery with known spatial data points, this essentially defines the location of a raster file and assigns real-world coordinates to the raster image, so that it may be analyzed accurately as a geographic data. Knowing at least two ground control points coordinates.

PROCEDURES FOR GEO-REFERENCING

1. Click on “Project” and select “New” the page is ready to work on; 2. Click on “Raster” and select Geo-referencer Tool. Add the save Raster image.

3. Set the Transformation Parameters.

1. Click on Transformation Type and select Polynomial 1 due to the number of points available to reference with. The more number the higher Polynomial to select.
2. “Resampling method” and select “linear”. For we are not dealing with height.
3. Target CRS; meaning the proposed coordinate reference system.
4. Output Raster; is the location (folder) the reference image will be save to output folder

5. Click “OK”.

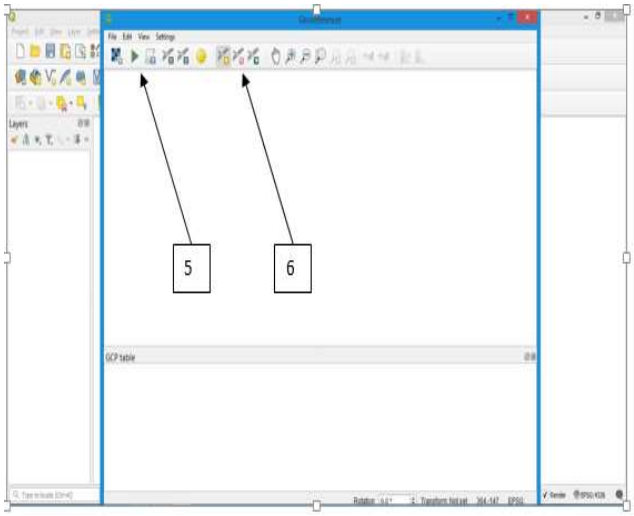


Fig.3.2. Showing “Georeferencer” dialogue box.

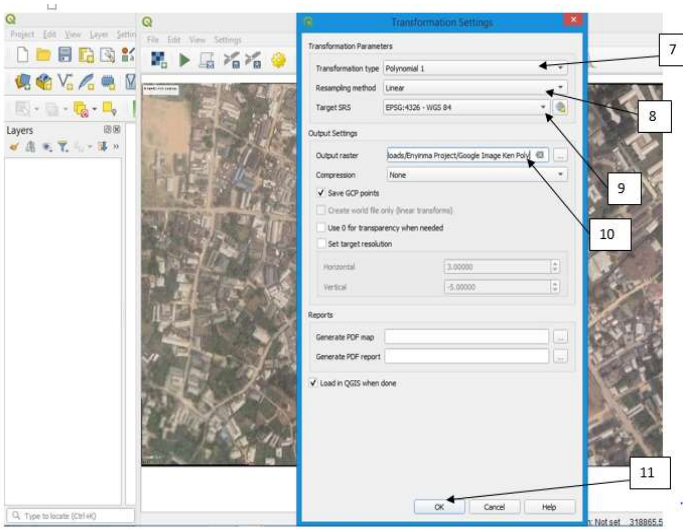


Fig.3.3. Showing “Transformation Parameters Settings”dialogue box

6. Click on “Add Point” and Zoom to the points one after the other. And left click, the “Enter Map Coordinate” dialogue box will appear; 7. Select the target Coordinate Reference System (CRS); 8. Open the coordinate points saved on Note Pad. Copy and paste the easting and northing accordingly. But when dealing with latitude and longitude, the longitude will be pasted as easting and latitude as northings; 8. And click on “Ok”. Repeat step 6,7 and 8 on each of the points.

9. These are the ground control Points, the result of the previous steps; 10. Click on “Start Georeferencing tool; 11. Click on “Close”.

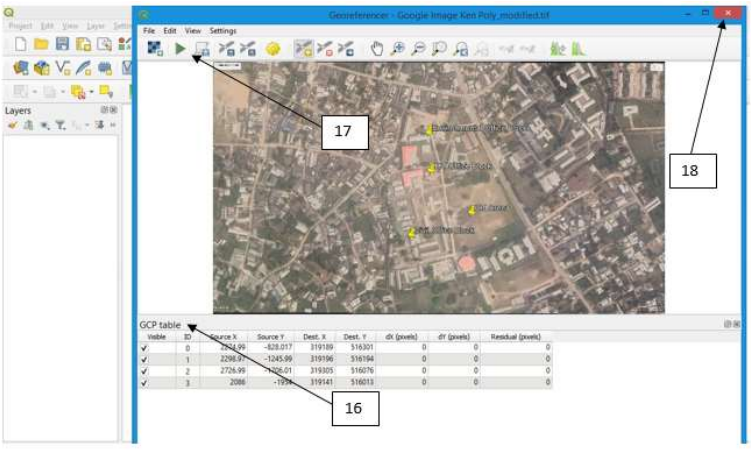


Fig.3.4. Showing “GCP table” Ground Control Points inputted.

DIGITIZING (Points, Roads, Buildings and Boundary).

These are process of converting geographic raster data either from a hardcopy (analogue) or a scanned (digital) image in to vector data by tracing the features. During the digitizing process, features from the georeferenced map are traced into various layers with their as either point, line

or polygon layers. This enables features to be assigned spatial and non-spatial attributes. Click on layer -- Create layer --- New Shape file layer.

The following steps form the attribute table for each of the layers to be created.

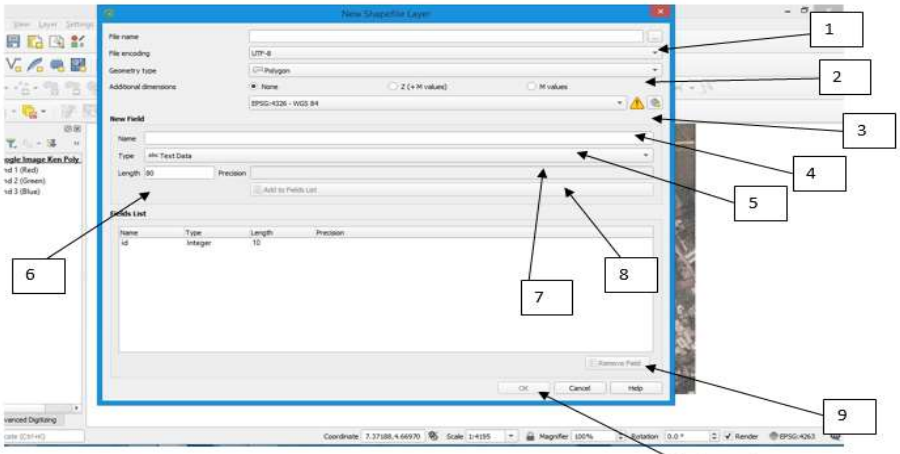


Fig.3.5. Showing "New Shapefile

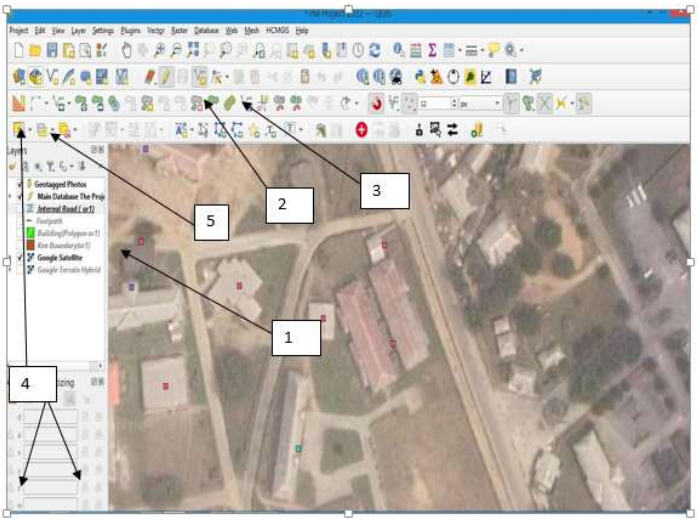
1. In put the output location and name of the layer. 2. Choose the Geometry type - No Geometry, Points, Multpoint, Linestring or Polygon. 3. Select the target Coordinate Reference System (CRS); 4. Name; type in the name of the file; 5. "Type" has the following items, which depends on the type of field to work on: -- Text Data (this permits all characters), Whole number (this permits only whole numbers), and Decimal number (this permits both whole numbers and those with decimal points), Date (this permits both whole numbers, those with decimal points and integers). ---Length; the maximum length of string or integers to be allowed. ---- Precision; this is the number of decimal places to tolerate and is only for decimal number and date; 6. Click on "Add to fields list", for it to be added to the fields list; 7. Click on "Remove field" by highlighting on any of field in the Fields list and click to remove; 8. Click on "Ok" to Create.

The following features were digitized , Internal Road as Linestring Layer, Main Database the Project as Point Layer, Footpath as Linestring Layer ,Building as Polygon Layer, Ken Boundary as Polygon Layer.

To add "**Base Map**"

1. Click HGMGIS ------- Basemap ------ Google Satellite.
2. Click HGMGIS -------- Basemap ------- Terrain Hybrid.

Example: Digitizing Internal Road layer.



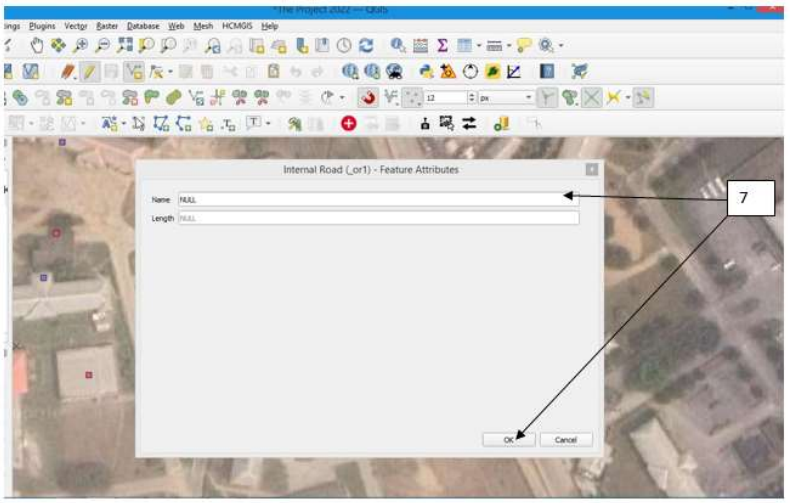


Fig.3.6. Digitizing Internal Road Layer"

Fig.3.7. Digitalizing Internal Road Layer

Click on the layer to digitalize on. --- "Internal Road Layer" --- Click on "Toggle Editing Tool"---- Click on "Add line feature"--- Click on "Advanced Digitalizing Tool".

- Select "Snap to common angle" _(90.0,180.0, 270.0, 360.0°)

Click on "Digitize with curve" to create a curve, or Ctrl+shift+G. --- Right click to save, the dialogue will display ---- Edit the file name, and click on "OK".

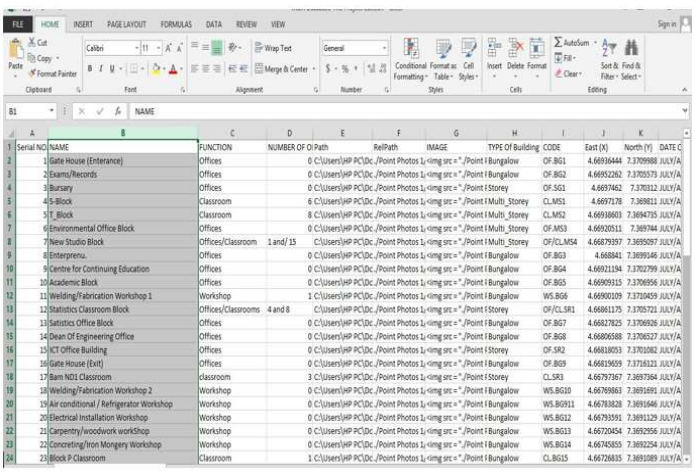
Similar steps are follow to add features to each of the layers above.

TABLE CREATION.

The attribute table of Point data layer was exported from QGIS to Microsoft Excel for proper table creation and import back to QGIS application. Also the attribute table can be created in QGIS, but it is time consuming needs more carefulness.

EXPORT THE POINT DATA ATTRIBUTE TO MICROSOFT EXCEL

- Right click on Point data. - Select Open Attribute Table. - Click on "Select All Tool". All the features on the attribute table will be highlighted -- Click on "Copy selection rows to clipboard (ctrl + c)". To copy all - Open Microsoft Excel and Paste. - Do proper table editing to achieve the table below.



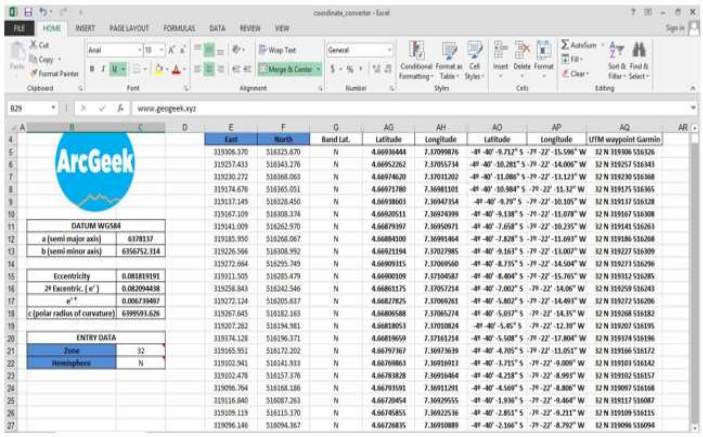


Table.3.1 Excel table creation. **Table3.2 Coordinate conversion table template**

- Note: that the coordinate are in latitude and longitude. For easy conversion
- Note the excel file must be saved in “CSV format

IMPORT THE CSV FILE INTO QGIS.

Open the QGIS application --- Click on “Layer” and select “Add Delimited Text Layer” ---- The file’s save path - --- The Layer name (file’s name) ---- Make sure the CSV (comma separate values) is selected.

1. The Geometry definition; select point coordinates --- Select the target Coordinate Reference System (CRS).

When dealing with latitude and longitude. Put the latitude on the y_field and longitude on the x_field.

Click on “Add and Close”

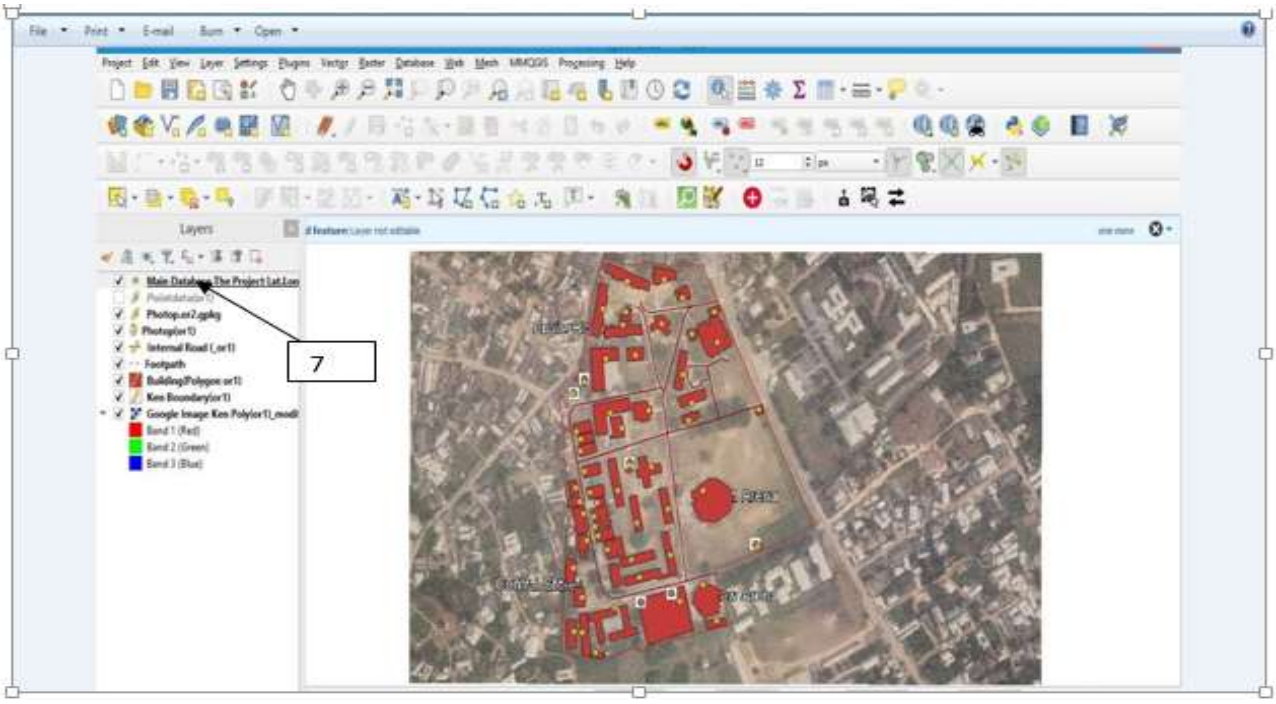


Fig.3.8. Showing "The Old and New Layer" dialogue box.

HYPERLINKING.

A hyperlink, also called a link or web link, contains an address for a destination and acts as a reference to data. A hyperlink can be a piece of text, an image, an icon, or a graphic that, when you click on it, points to and navigates you to a different webpage or document. It can also point to a specific section or element within the same webpage or document.

HYPERLINKING UNGEOTAGGED PHOTOGRAPHS.

1. --- Right click on the "Point Layer" ---- Select Properties ----- Select Attribute form and click on the field to hyperlinking to ------- Select Attribute form and click on the field to hyperlinking to

2. Under the "Widget type" select "Attachment" that is, because we are attaching a document which can be an image or text. And click on "Select Existing File".
   Click on the following, Display Resource Path, Display button to open the file dialog, Use a hyperlink for document path (read- only), and Display the full path.

3. Under "Integrated document viewer" click and select the following.
   - Under the "Type" select "Image". For is Image document is what will be viewed.

- “Width and Height”, this is to specify the size of the preview, it can be left as “Auto”on both. But is not all that important for the “Default path link” is on display. And through this link, the image can viewed or accessed.

4. Click on “Apply” and “Ok”.
5. Using the “identifier tool” to click on any point, the image or photo will appear with attribute information.

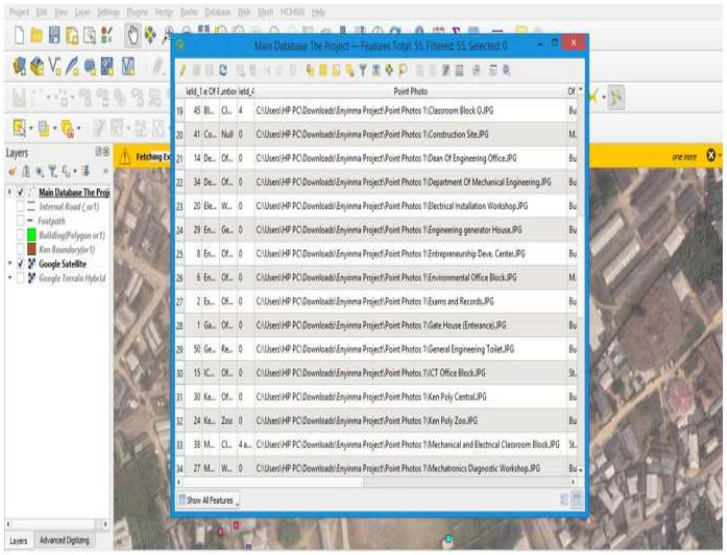


Fig.3.9. The Attributes Form dialogue box.

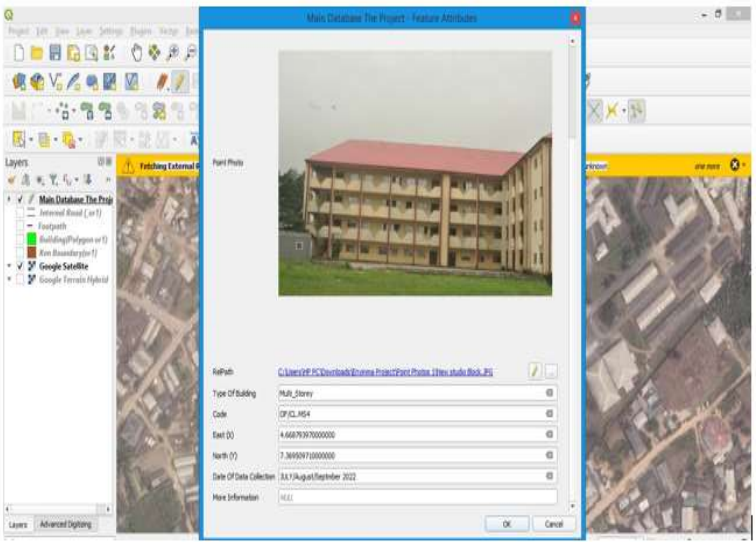


Fig.3.10. Hyperlinked image for New Studio Building in QGIS.

RESULT AND DATA PRESENTATION

CREATING WEB MAP

At this point all the layers has been created.

Download qgis2web plugin.

Click of “Web”, select “qigs2web” and “create web map”.

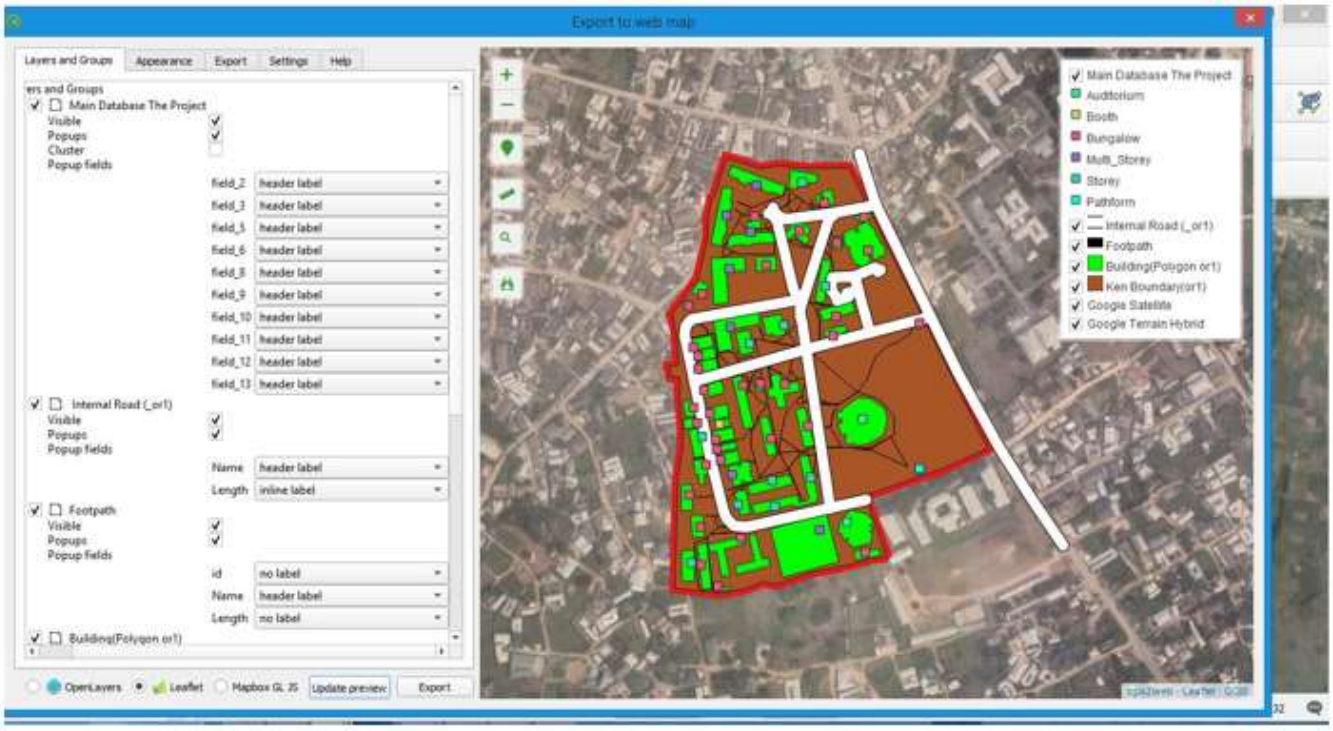


Fig.4.1 Export to web map, “Layers and Groups” option dialogue box.

1 Select the Layers and Group tab. The following are items to consider for each of the layers

- Click on Leaflet
- Visible: click to see the layer or not
- Popups: click to see the layer or not, the field under it.

2 Select the Appearance tab. The options shows the characteristics physical features of the web map.

3 Under the Export tab option dialogue box

4 Choose the folder to export to by clicking on the folder and selecting the folder of the subsequent exported web maps.

Any changes can be preview before export the web map; by clicking on the “Update preview”.

Then export when satisfied with how the map should appear.

After exporting to the default browser “chrome”.

1. Go to qgis2web folder that will be created, right-click the HTML icon and open with a text editor (sublime text). Scroll down to “pop up” section , copy and paste the “Relative Path” (Line 233-236)
2. Edit the copied part by introducing “<img src =” in (line 237) and deleting unwanted scripts. See the image above.
3. Refresh and click on a point and a small icon will appear.
4. Inspect the icon and copy the folder containing the photographs and paste it in the qgis2web exported file folder.

5. Now click on a point to view the photograph of the location.

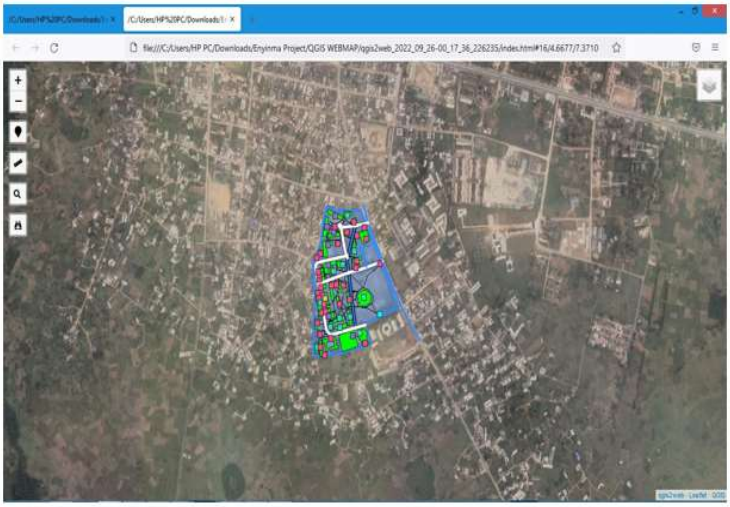


Fig. 4.2 Web Map Exported to Chrome.

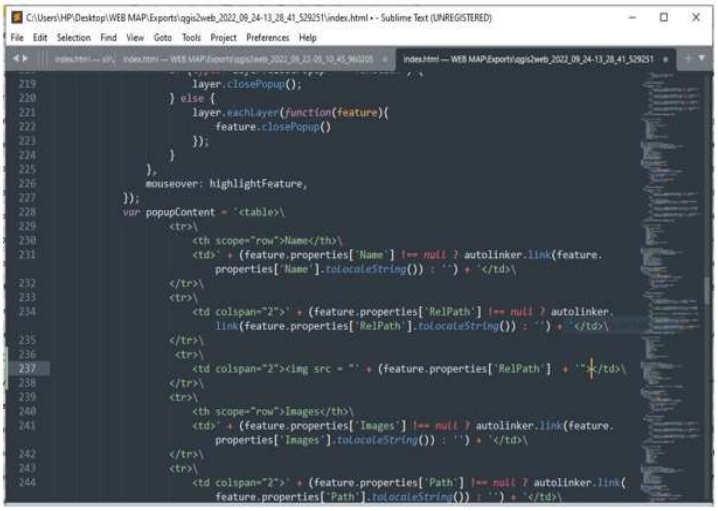


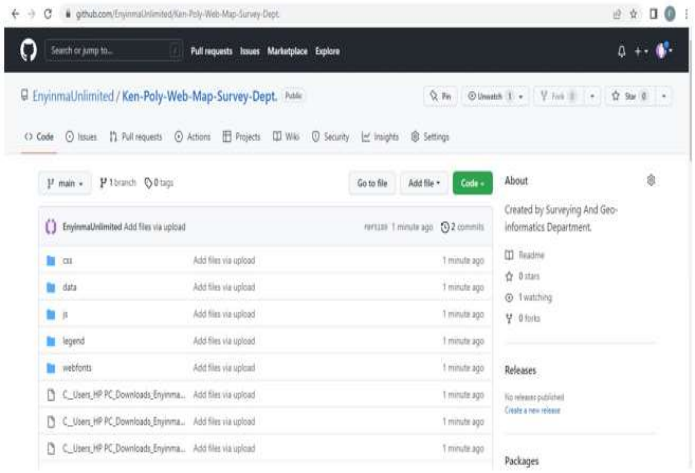
Fig. 4.3 Part of Sublime Text

HOSTING (CREATING A WEB LINK).

Hosting or creating a web link means making the files publicly accessible on the internet, so anyone with the web link can visit it. This was done through a website called “GITHUB.COM”
GitHub is an increasingly popular programming resource used for code sharing. It's a social networking site for programmers that many companies and organizations use to facilitate project management, collaboration and hosting of personal files, example, scripts, document from emails, map hosting.

PROCEDURES FOR UPLOADING THE FILES (REPOSITORIES)

- Login to Github.com
- Create an account
- Sign in
- Add a “Create a New repository” by clicking on the icon showed below.
- Input the repository new.
- Write a little “Description (optional)”
- Click on public: for the web to be made public.
- Scroll down and click on “Create repository”.
- Click on add files, which can be done either by uploading or dragging.



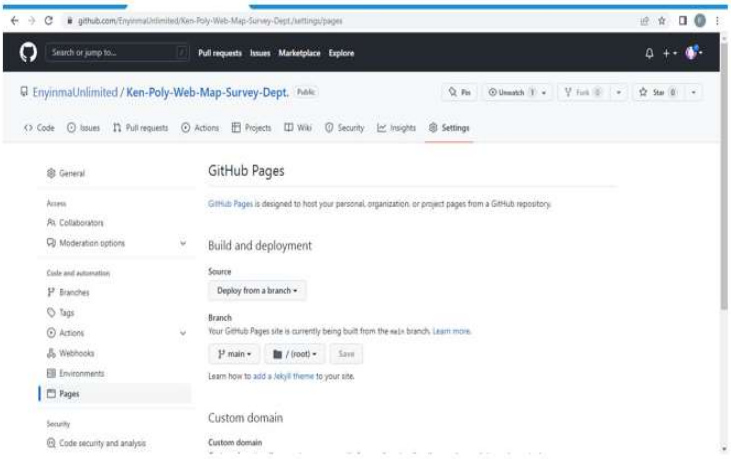


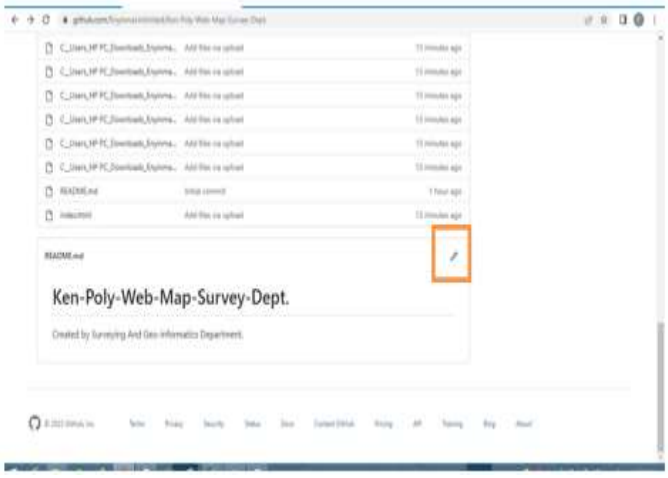
Fig. 4.4 Add Files dialogue box.

Fig. 4.5 GitHub Pages dialogue box.

- click on “Settings”
- Click on “Pages” at the left hand side. Which will take you to “GitHub Pages”
- Under Source; select “Deploy from a branch”
- Under Branch; select “main”--------- root and ------- Save.
-

The web link will display, which was copied.

- Go back to the main page.
- Scroll down and click on the “Read me” icon.
- And paste as number “3”.
- Scroll down and “click on comment changes”.



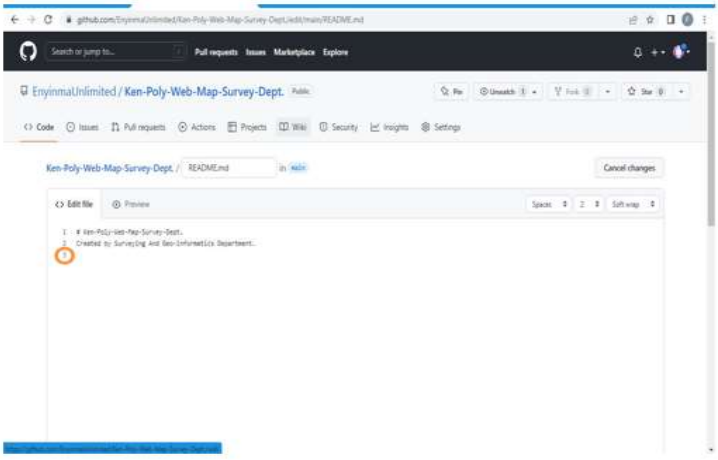


Fig. 4.6: Showing the click on the “Read me” icon.

Fig. 4.7: Showing the “number three”.

The link is ready to be shared with anyone. By clicking on the link the map can be accessed by all

CONCLUSION

In course of the executing this project diverse methods and forms of Geographical information system were displayed using various information Gis applications.

Which are as follows.

- Image extraction using Google earth pro
- Geo-referencing using QGIS
- Digitizing using QGIS
- Database creation using Microsoft Excel
- Acquisition of Geotagged and ungeotagged photos using GPS Map camera and non-meteic camera.
- Hyperlinking photos to point data using QGIS
- Creation of web map using QGIS
- Publishing web map in Github website

This was carried out in order to achieve the desired result which is the web mapping of engineering campus of Ken Saro-Wiwa Polytechnic, Bori

This project can be accessed using any web browser using these web link
https://enyinmaunlimited.github.io./Ken-Poly-Web-Map-Survey-Dept./
https://enyinmaunlimited.github.io/KenPolyWapMap/ and
https://francis2161.github.io/KenPoly/

REFERENCE

A. Christl, "Open Source: Trends auf der Fossgis," GIS Business, Vol. 3, 2009, pp. 46-47.

A. P. Longley, Geographic information systems and sciences, edition Wiley, 2004.

B. Kurniawam, JSP and Servlets: a tutorial, 2012.

Bakary A., Conception etmise en oeuvre d'un SIG pour le suivi des investissements publics au Cameroun, Mémoire Ingénieur de conception en informatique, Ecole Nationale Supérieure Polytechnique de Yaoundé, 2009.

C. Kreutz, G. Rambaldi, Online Mapping for development: Opportunities and Challenges}, available at the url http://www.Web2fordev.net/component/content/article/1-latest-news/76-mapping

Centre National d'EtudesSpatialesFrance : Rapport de l'étude des bases de donnéesspatialisées, available at rapport_etude_spatiale_final?, 2007.

Doudoux J.M., Développons en Java version 1.6 available at http://www.www.jmdoudoux.fr-/java/dej/indexavecframes.htm.

E. Simonné-Dombóvári, M. Schmidt and G. Gartner, "Mapapplications in the Web," HMD: Practise of Economyinformatics, Vol. 47, No. 276, 2010, pp. 59-67.

F. Dickmann, “Effectiveness and Efficiency of Tourism Maps in the World Wide Web and their Potential for Mobile Map Service,” In: L. Meng, A. Zipf and T. Reichenbacher, Eds., Map-Based Mobile Services. Theories, Methods and Implementations, Springer, Berlin etc., 2005, pp. 43-53. [Citation Time(s):1]

GIS dictionary http://support.esri.com/en/knowledge based /Gisdictionary

Goodchild, M.F.; Guo, H.; Annoni, A.; Bian, L.; de Bie, K.; Campbell, F.; Craglia, M.; Ehlers, M.; van Gendern, J.; Jackson, D.; et al. (2012) Next-generation digital earth. Proc. Natl. Acad. Sci. USA , 109, 11088–11094.

H. K.-C. Chang and M.-H.Tsou, “New Approaches for Integrating GIS layers and Remote Sensing Imagery for Online Mapping Services,” In: M. P. Peterson, Eds., International Perspectives on Maps and the Internet, Springer, Berlin, 2008, pp. 73-87. [Citation Time(s):1]

Hall, W.; Tiropanis, T. Web evolution and Web science. Comput.Netw. 2012, 56, 3859–3865. 5. Hess, S. (2002) GRASS on the Web. In Proceedings of the Open Source GIS−GRASS Users Conference, Trento, 11–13,1–14.

Ham N. (2016). How Far Have We Progressed against the Digital Earth Vision Retrived from: http://sensorsandsystems.com/how-far-have-weprogressed-against-the-digital-earth-vision/

J. Murach, A. Steelman, Java Servlets and JSP, Murach publishing, 2008.

K. Hoffmann, “Usergenerated Maps and Cartographic Communication in the Web 2.0,” Cartographic News, Vol. 61, No. 2, 2011, pp. 72-78.

Kraak M-J (2001) Settings and needs for web cartography. In: Kraak M-J, Brown A (eds) Web cartography. Taylor & Francis, New York, pp 3–4

K. Weissinger, ASP in a Nutshell, second edition, O'Reilly, 2000.

M. Haklay, A. Singleton and C. Parker, “Web Mapping 2.0: The Neogeography of the GeoWeb,” Geography Compass, Vol. 2, No. 6, 2008, pp. 2011-2039. doi:10.1111/j.1749-8198.2008.00167.x

M. Jansen and T. Adams, “OpenLayers, Web Development with Dynamic Maps,” Open Source Press, München, 2010. [Citation Time(s):1]

M. Soutschek, “Usage of Geoweb-Technologies in Tourism,” HMD: Practice of Economy Informatics, Vol. 47, No. 276, 2010, pp. 77-87.

M. Tranchant, Veilletechnologique: UE NFE107 Architecture etUrbanisation de Systèmesd'Information, Rapport Technique, Décembre 2008.

Neumann, A. (2008). Web Mapping and Web Cartography. In Encyclopedia of GIS; 1261–1270.

P. L. Pulsifer, A. Hayes, J.-P.Fiset and F. D. R. Taylor, “An Open Source Development Framework in Support of Cartographic Integration,” In: M. P. Peterson, Ed., International Perspectives on Maps and the Internet, Springer, Berlin etc., 2008, pp. 165-185 [Citation Time(s):2]

Roques P., UML2 Modéliserune application Web, Editions Eyrolles, Fourth Edition, 2008.

S. Davis, GIS for Web developers, Adding where to your Web applications, The Pragmatic BookShelf, 2007.

St L. Simon, Web mapping, O'Reilly Editor, 2005.

T. Converse, J. Park, PHP Bible, second edition, Wiley publishing, 2002.

T. Mitchell, Web mapping illustrated, O'Reilly publisher, June 2005.

Veenendaal B, BrovelliMA, Songnian Li (2017). Review of Web Mapping: Eras, Trends and Directions. J. Geo-Inf., 6(10), 317

W. Kainz, The Mathematics of GIS, available at The_Mathematics_of_GIS_Draft.pdf, 2010