GEOEDGE MAP ENGINE: SPATIAL DATA SHARING & VISUALIZATION TOOL FOR COLLABORATIVE MAP EDITING

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ABSTRACT:

GeoEDGE Map Engine has the basic Web GIS components such as facilities to add and upload new layer(s), create new maps, layer overlay, layer transparency, layer/map styling, map printing and functionalities for basic spatial analysis (such as clipping, buffering and intersection) and sharing the whole work process among a group of team members who are working in the same project. This collaborative work support is a useful feature not only related to disaster management but to any mapping process where several members in different locations need to share data and prepare maps. The first version of the tool had been installed and commissioned in the Asian Disaster Preparedness Center (ADPC) and GeoInformatic Center (GIC), Thailand, to support the disaster management activities way back in 2015. Several open source technologies are used for the development of GeoEDGE Map Engine. PHP and Python are mainly used for backend development with HTML(5), CSS(3), JavaScript, jQuery(1.7), JSON and Bootstrap(3.3) are used for frontend development. System runs on Apache (v2.4) web server and PostgreSQL. An object relational database management system is used for data management. GeoEDGE Map Engine can integrate with multiple formats of base maps such as OSM, Google Maps, OpenLayers and Bing Maps and vector layers in shape file and GeoJSON formats. MapFish is used to provide print support. New version of GeoEdge MapEngine (v2.0) is being developed with additional functionalities, increased performance and security using the Python framework Django (v1.11). Using the Django framework helps to use more python extensions and packages to achieve expected performance with additional features.

INTRODUCTION

Geographic Information System (GIS) is one of the rapidly developing application types in the current situation. Most of commercial GIS applications have high functionalities, that developed by newest software engineering technologies. Due to that, the cost of the license fee will be high. People who are working on Geospacial and Geoinformatic sector, have to bear the cost of application development cost or cost of the license fee to purchase or to use. The fast development of internet and World Wide Web (WWW) technologies, the whole process is changed and, it is doing integral role of GIS. Web-based Geographic Information Systems (WebGIS) and its services could be accessed via the internet. It can manage special and non-special data. WebGIS helps for effective analysis and take correct management decisions on time.

GeoEDGE Map Engine (www.geoedgemaps.com), a product initiated from Sri Lanka is a simple Web GIS tool enable with online web mapping services to create modify, analysis, visualize and share spatial data working as a team. The first version of the tool had been installed and commissioned in the Asian Disaster Preparedness Center (ADPC) and GeoInformatic Center (GIC), Thailand, to support the disaster management activities in 2015.

DESIGN AND IMPLEMENTATION

The development of web application can be categorized into two-tier architecture and three-tier architecture. It is depended on the data storing and processing requirement of the client. The presentation or interface layer runs on a client, and a data layer runs on a server in two-client architecture (Singh P S). The first version of GeoEDGE MapEngine (v1.0) has developed on two-tier architecture. The focus of the new design and implementation is; to increase efficiency of the system, utilizing the new technology and three-tier architecture (Tian H).

Application Architecture

The application is totally web-based solution, which can facilitate the users to input data, process and get output data and information as spatial and non-spatial data. Single or multiple users (group of users) can open an account through the web application. Three-tier architecture uses to manage the efficiency of the application (Chakraborty D, 2015). It consists of three basic components; presentation/interface layer, application and database layer. The application architecture is in Figure 1. Client allows to make user account, upload spatial data, process data and display information as map or as a new layer file. All types of web browsers are used to access the application but Chrome and Firefox are recommended. The application is hosted in the web server; Web server use HTTPS (Hypertext Transfer Protocol Secure) protocol to transfer results according to client's requests.

Tools and Technology

Opensource web technology used to develop the application. HTML5, CSS3, JavaScript, JQuery, Bootstrap and leaflet used to develop the user interfaces of the web application. Reasons to use HTML5 (Hyper Text Markup Language) are; it has elements to support multimedia without using Flash or other third party plugins, Geolocation allows the site to detect the location, compatibility of other devices such as Laptops, Tablets, Mobile devices (support to create responsive web application and cross platform); and; support to any browsers (modern and popular browsers) such as Chrome, Firefox, Safari and Opera. JavaScript is client-side scripting language. It is written into HTML documents and users can work even offline. JavaScript supports to create highly responsive interfaces and maintain UI's presentation and provide dynamic functionality without having to wait for the server response. Leaflet (v1.3.1) is open source JavaScript library which is used to make web mapping application. The working environment of Leaflet is simple and of high performance and support to desktop and mobile platform. The jQuery is featured-rich JavaScript library. JSON (JavaScript Object Notation) is used as a lightweight data-interchange format. Bootstrap framework is used to design the layout of the web application in a responsive way. It compatible with all modern browsers such as Chrome, Firefox, Internet Explorer, Safari and Opera.

The core of the map engine is developed by Python language. Python is developed under an OSI-approved open source license, making it freely usable and distributable, even for commercial use (https://www.python.org). It is interpreted, high-level and general-purpose programming language. All the client's requests receiving and processors of responses, front end and back end communication functions are developed by python (v2.7.5) language. To maintain high security of the application, Django framework (v1.11) is used. Django is a high-level Python based, free and open source web framework (https://www.djangoproject.com). It encourages rapid development and clean, pragmatic design. it helps to avoid many common Security mistakes. Apart from that, several Phyton extensions such as GeoDjango, GeoJSON and Psycopg are used.

PostgreSQL (v9.6) is a free and open-source object relational database management system (ORDBMS). PostGIS (v2.3.7) is a spatial database extension of PostgreSQL database that supports for geographic objects to the PostgreSQL. The PostGIS implements efficient geometry types such as Points, Line Strings, Polygons, MultiPoint, Multiline Strings, Multi-Polygons.

GDAL (Geospatial Data Abstraction Library, v1.11.4) is a vector and raster processing library and has been developed a strong focus on supporting a large number of raster and vector geospatial data formats. GDAL is being able to translate between the different geospatial data formats and fostering data exchange. The GDAL Python package provides a wrapper around the GDAL C++ library that allows for using its functionality in Python (https://www.e-education.psu.edu/geog489/l3_p6.html). The MapEngine does not use any GIS server such as MapServer and GeoServer. The GDAL library covers the process of GIS server.

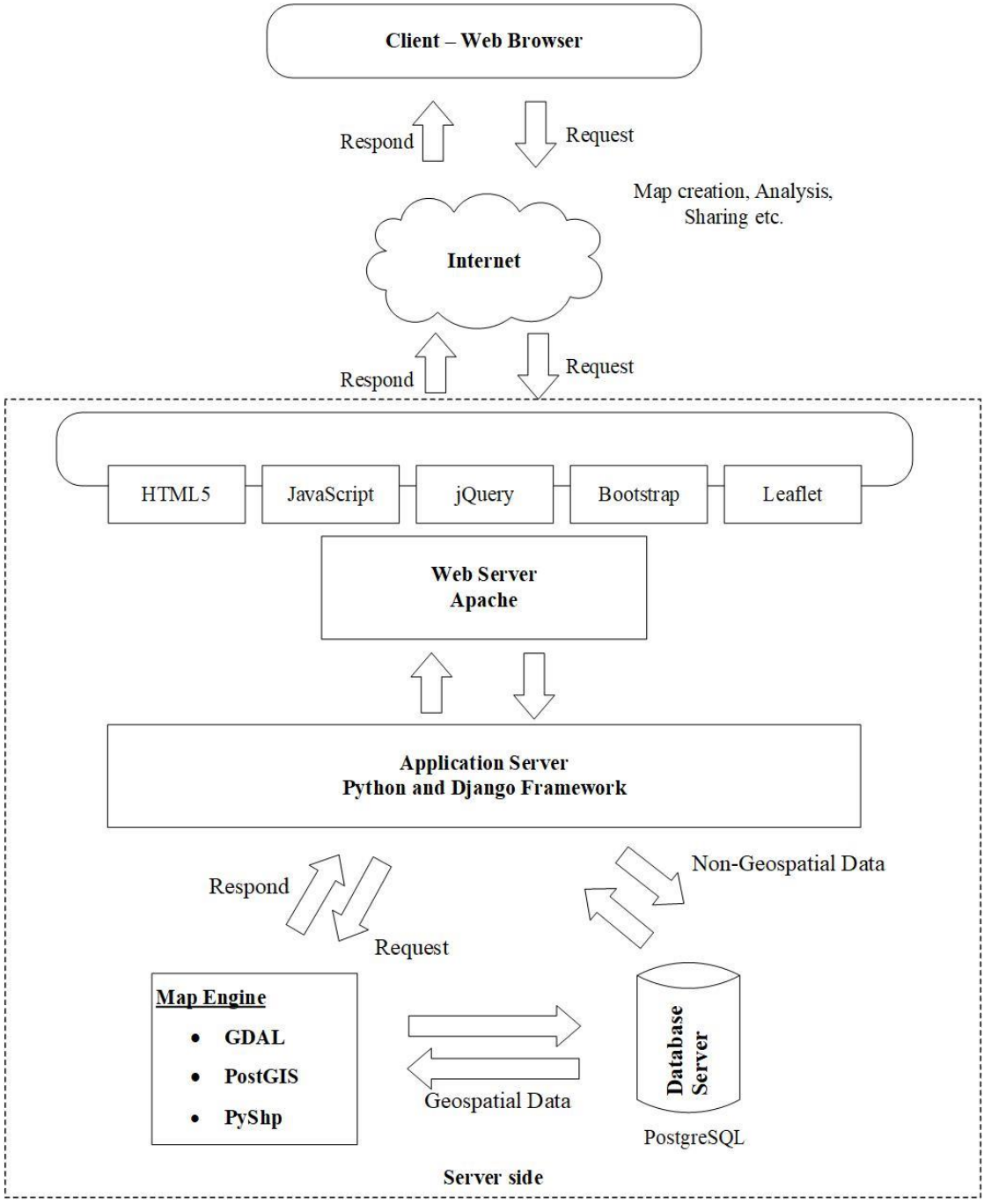

Figure 1:Architecture of the GeoEDGE MapEngine

PyShp (Python Shapefile, v2.1.0) Library provides facility to read and write support for the Esri Shapfile format. The Shapefile is a popular vector data format in the GeoGraphic Information System (GIS) created by Esri.

Map printing is one of the key features of GoeEDGE MapEngine. MapFish is used to map printing. It is flexible and complete framework based on Python web framework. MapFish provides specific tools and RIA-oriented JavaScript toolbox to query and edit geographic objects. MapFish is compliant with the Open Geospatial Consortium standards. This is achieved through OpenLayers or GeoExt supporting several OGC norms, like WMS, WFS, WMC, KML, GML etc.

The MapEngine

The MapEngine of this application works without using GIS server. GDAL, Pyshp python libraries and PostGIS are used to vector data conversion and analysis. Users can upload Shapefiles, KML and GeoJSON files to the system.

Shapefiles contents a bundle of supporting file under the extension of .shp, .dbf, .prj and . shx. User can upload shapefiles through the web interface. Two parts are considered the file uploading process. First one is, file uploading to temporary location. Second is, the process of the MapEngine during the file upload. When uploading files, those files are stored in the temporary location of the server. The progress bar represents uploading status as percentage (80% - 90%) and by text message.

In the Second part of the file uploading, the MapEngine checks the projection of the shapefile when stored the files, Reprojection the file, create database tables and remove the temporary files from the server. WGS84 projected coordinate system uses for rendering maps in Google Maps, OpenStreetMaps, Leaflet etc. EPSG:4326 is the identifier of WGS84. If it does not have proper projection or other projection system then it will be converted to WGS84 automatically. GDAL Creates GeoJSON file using data from PostgresQL database and push to map viewer of MapEngine. The work flow of the MapEngine is shown below Figure 2.

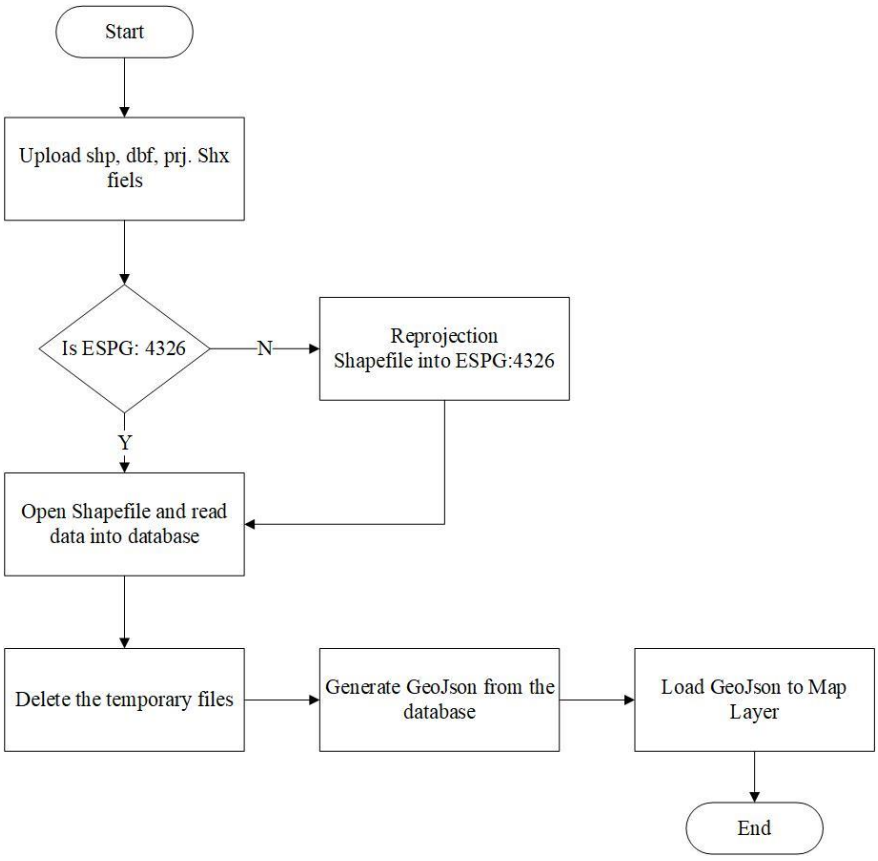

Figure 2: The flow of the MapEngine

Interaction of PostgreSQL and MapEngine

All the spatial data store in the PostgreSQL database. PostGIS uses to convert Shapefile to geographic objects and save into PostgreSQL database. “shp2pgsql” command can extract the shapefile data into SQL. When user request to load the layer files or maps in to the map viewer, then, MapEngine convert SQL data into GeoJSON file format by using GDAL library. PostGIS provides two tables to track and report on the geometry types available in a given database (http://postgis.net). The first table (spatial_ref_sys) keeps all the spatial reference in the database. tTe second table (geometry_columns) provides all features (geometric attributes) and the basic details of those features.

Graphical User Interface (GUI)

Interactive web application is developed by using HTML5 and CSS3. Bootstrap helps to make user friendly and responsive look and feel to web interfaces.

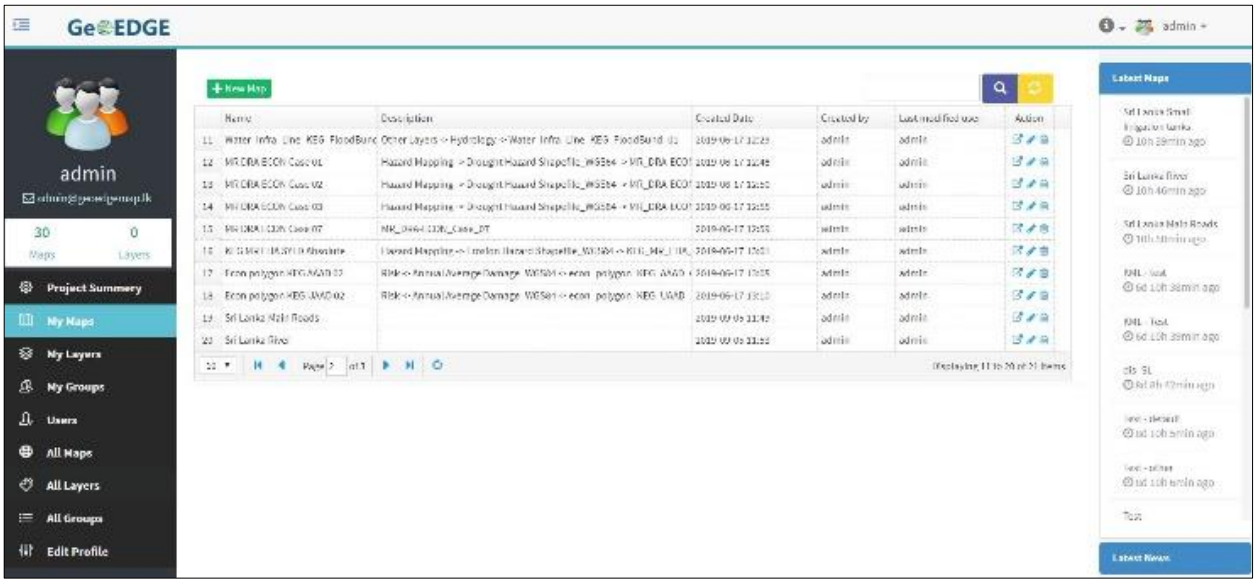

Figure 3: User Interfaces

FUNCTION OF THE MAPENGINE

The MapEngine is already hosted into the dedicated server. Users can open own account and use it free. It is very user-friendly application and the main feature is, it can be customized easily and integrated into the other web application. It can use as separate web application and can be used after quick customization with other application.

User Profile

Uses can open a new account. When it opens, the system generates the user profile. First, the Dashboard is appeared (Figure 4). It shows quick indicator, such as number of maps and layer files are created, project summery, My Maps, My Layers, My groups, user information etc.

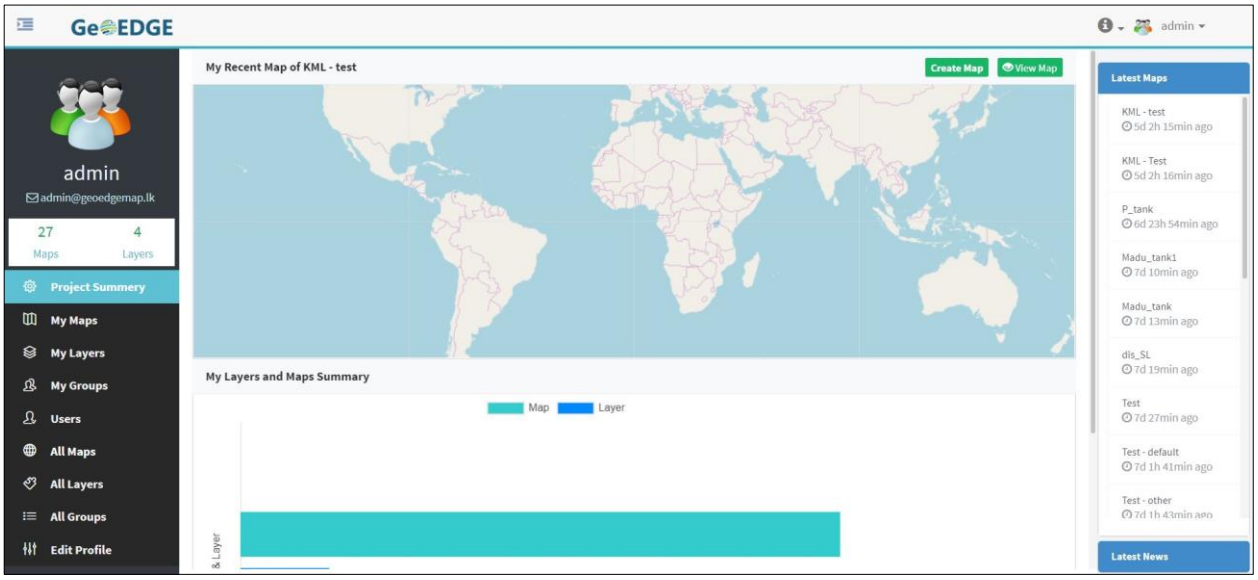

Figure 4: Dashboard of the user

Add New Layer and Map Creation

To create new layer or map, there is an option called “MapEngine” to open work area. It provides several tools such as Layer settings side panel, add/upload layer, Quick Tour, New Map,Print Map, Share map, settings, Download map, Save map, Profile indicator, and Map Style & analysis widget to manage user maps and upload layers. User can

change the Map viewer as OSM, Google Satellite, Google Terrain or Bing Map. User can upload new layer (Shapefiles, KML or GeoJSON) files using Add/Upload layer panel. The Add/Upload layer panel has two options; to upload new layer files and to find the existing layers files. While uploading the layer file, the MapEngine check the projection and; if it is not in WGS84 then converts and; store into the database; and show on the map viewer.

Layer Styling

The styles and analysis panel of the MapEngine consists of several features such as Map Style, Layer Style, Layer Information Window, Charts, Spatial Analysis, Filters and labeling. There ae several map styles available in the map style panel. Users can change the layer styles using Simple, Categorized, Classify and Bubble layer styles. Layer information shows attribute table of the layer. Chart panel can make the chart according to the user requirements. Basic spatial analysis methods (Clipping, Buffering and Intersection) are available. The filter option supports to select the particular object using by property of the attribute table.

Control Panel

Control panel provides on/off facility for important tools such as My location, Info window, Digitizing tool box, Measurements tool box, Legend and Swipe control. Digitizing tool box shows line, polygon, points, rectangle, edit layer and delete options. Measurement options are available in the measurement tool.

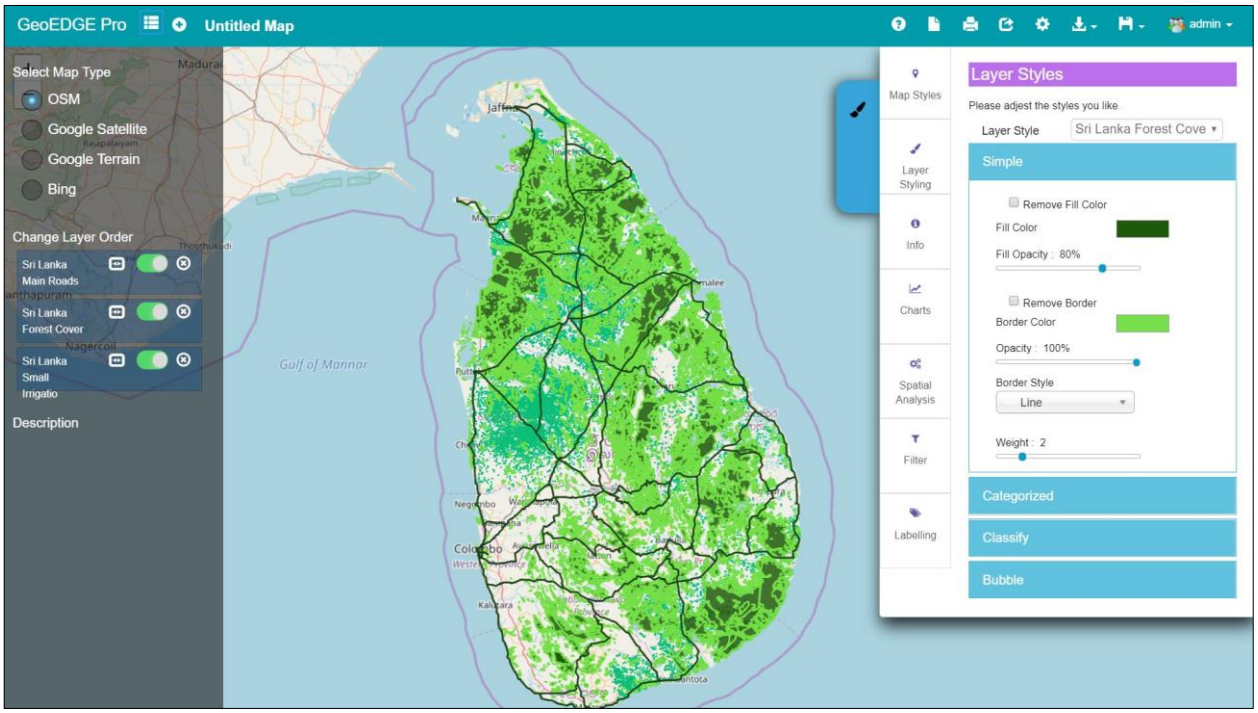

Figure 5: Map styling

Map Layouts and Data Sharing

Map layouts can be prepared using “Map Layout” tool box. Ledged, North arrow, Scale bar, Indicator can add into the map layout. When complete the map layout then it should save before creating the share link. The map sharing tool has two option; share by URL and add to your page. Share by URL option provides URL to share the map though email or social media. The second option can be used to generate iframe and it can put in to own website.

<iframe width="800" height="600"
src="https://geoedgemaps.com/geoedgeprov/map/share_map/33/layer" frameborder="0" allowfullscreen></iframe>

Download Maps and Layers

Apart from the map printing the system has a facility to download map and layer as a shapefile, KML and GeoJSON file (Figure 6). If user requests to download shapefile from map viewer, a new shapefile with the WGS84 standard

will be generated from the database by using GDAL library and zipped. The zip archive will be provided to user. PostGIS get spatial data from the database to convert shapefile format.

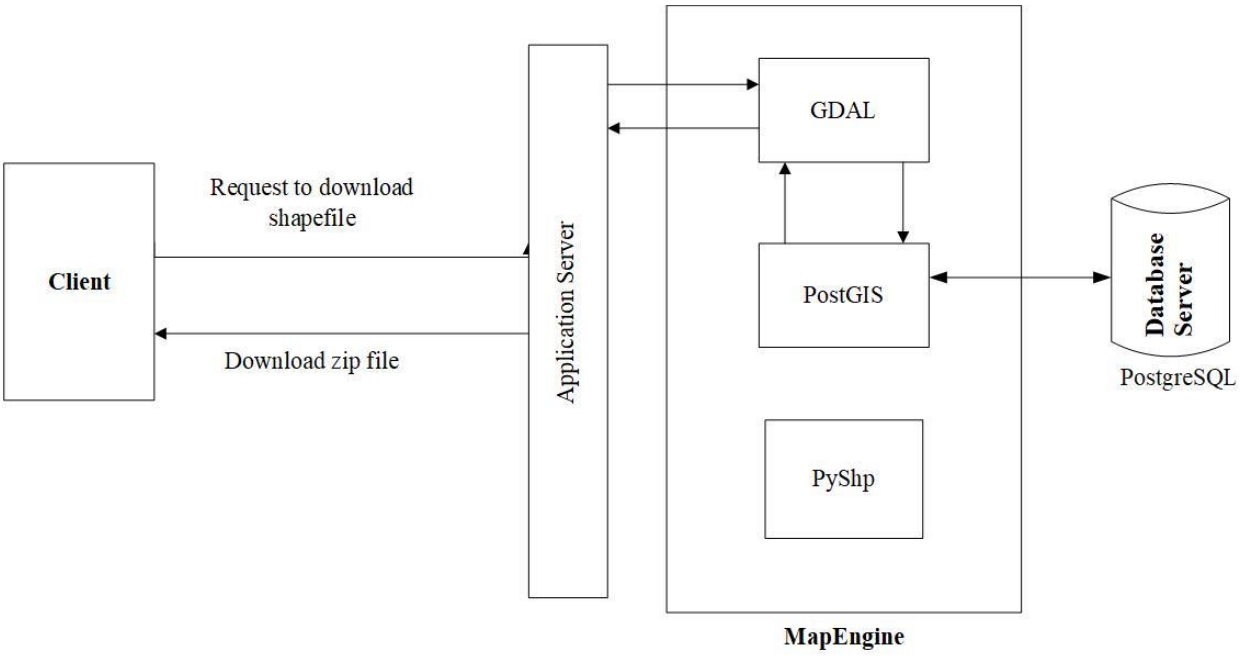

Figure 6: The flow of the spatial data download

RESULT AND DISCUSSION

The developed MapEngine (version 2.0) consists of various useful GIS functions to spatial data analysis, visualization, sharing and map printing. The effective application architecture supports to manage the client requests and quick response after the process of MapEngine. The object relational database management system allows to store spatial and non-spatial data, to manage and retrieve data efficiently. Latest open source web technology such as PostgreSQL, PostGIS, Phyton, Django framework, Apache server (v.2.4) and Phyton libraries used to develop the MapEngine. It does not use any GIS server as MapServer or GeoServer. The MapEngine can be customize according to the requirement of web GIS application. It provides facilities to spatial analysis, sharing data and map printing for GIS and Non-GIS users. The web application support to create individual and group of users.

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