Development of Educational Geospatial Database for Cloud SDI Using Open Source GIS

Rabindra K. Barik, R. K. Lenka, S. R. Sahoo, B. B. Das and J. Pattnaik

Abstract Open source software (OSS) can be used for the development of geospatial database in cloud computing environment. Open source GIS (OSGIS) yields strong spatial solutions in a cost-effective manner and used for work connected to geospatial database creation, geospatial Web services, geospatial database storage, etc. The present work critically analyzes two popular OSGIS software i.e., Quantum GIS and Map Window GIS for geospatial database creation to give better comprehension of procedure and execution in education sector with cloud SDI. Presently, geospatial database provides detailed information about the entire technical institute of Odisha in test case. The objective is to deliver spatial statistics at reasonable costs and anticipated to be advantageous for stake holders such as students, parents, faculty members, government organizations. The same may be scaled up in future for technical institutes of other states in India.

Keywords GIS · Open source · Geospatial database · Cloud SDI

R. K. Barik (✉)
School of Computer Application, KIIT University, Bhubaneswar, India
e-mail: rabindra.mnnit@gmail.com

R. K. Lenka
Department of Computer Science & Engineering, IIIT Bhubaneswar, Bhubaneswar, India
e-mail: rakeshkumar@iiit-bh.ac.in

S. R. Sahoo · B. B. Das
Department of Computer Science & Engineering,
C.V. Raman College of Engineering, Bhubaneswar, India
e-mail: mlswagat@gmail.com

B. B. Das
e-mail: banee.bandana@gmail.com

J. Pattnaik
CSM Technologies Pvt Ltd, Bhubaneswar, India
e-mail: jashikapattnaik24@gmail.com

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1 Introduction

The energetic progression degree of the economic system and technological engineering of any nation certifies a quick improvement in the education sector, by which maximum of the manpower helps to serve the country. This qualified manpower contributes extensively to the economy of nation in terms of financial and technological development. In order to yield excellent manpower, educational segments which is vital and faced by an elevated race on the level of technology employed and on account of globalization; hence demanding fresh innovations to mitigate the forthcoming challenges. A coordinated effort can result in people encouragement and extract improved information on the eminence of educational details in a much advanced manner by the integration of current tools. The technological platforms like GIS, remote sensing, and GPS used to evacuate the hindrance which hampers efficiency and proficiency in the area [1].

Fortunately, in the field of GIS applications, the proprietary software competed by many open source software [2, 3]. Developers have created many open source libraries and GIS sets to handle huge data of GIS and its layouts. Open Geospatial Consortium (OGC) aims to strengthen utility of development of community-led projects and open source GIS standards [4, 5]. The geospatial Web services, database creation, spatial modeling services can use the open source GIS software [6]. This software is also utilized for development of geospatial database which contains Map Window GIS and Quantum GIS. The geospatial database is one of the most vital components for spatial data infrastructure (SDI) model. SDI is implemented in cloud computing environment. A specific Cloud SDI Model has been described in the next section.

2 Cloud SDI Model

Cloud SDI Model delivers a platform in which organizations interrelate with technologies, tools, and expertise to nurture deeds for producing, handling, and using geographical statistics and data. SDI also defines the cumulative of technology, standards, strategies, policies, and manpower required to attain, allot, sustain, process, use, and reserve spatial data. The basic constituents of SDI have been observed as data, networking, public, policy, and standards [7–10]. Further, SDI Model can be implemented through service-oriented architecture (SOA) or cloud computing technologies for better and efficient use. The SOA tries to construct dynamic, distributed, and flexible facility system over the Web in order to see data and required services for development of SDI. Components in the service-oriented architecture-based spatial data infrastructure are geospatial Web services i.e., structured collections of activities which are stateless, self-confined, and independent upon the state of other services [11–17].

Likewise, Cloud SDI Model deploys a unique-instance, multitenant design, and permitting more than one client to contribute assets without disrupting each other. This integrated hosted service method helps installing patches and application advancements for user's transparency. Geospatial Cloud another characteristic is embrace of web services and SOA, a wholly established architectural methodology in the engineering [18]. Many cloud platforms uncover the applications statistics and functionalities via Web service. This permits a client to query/update different types of cloud services and applications data programmatically, along with the

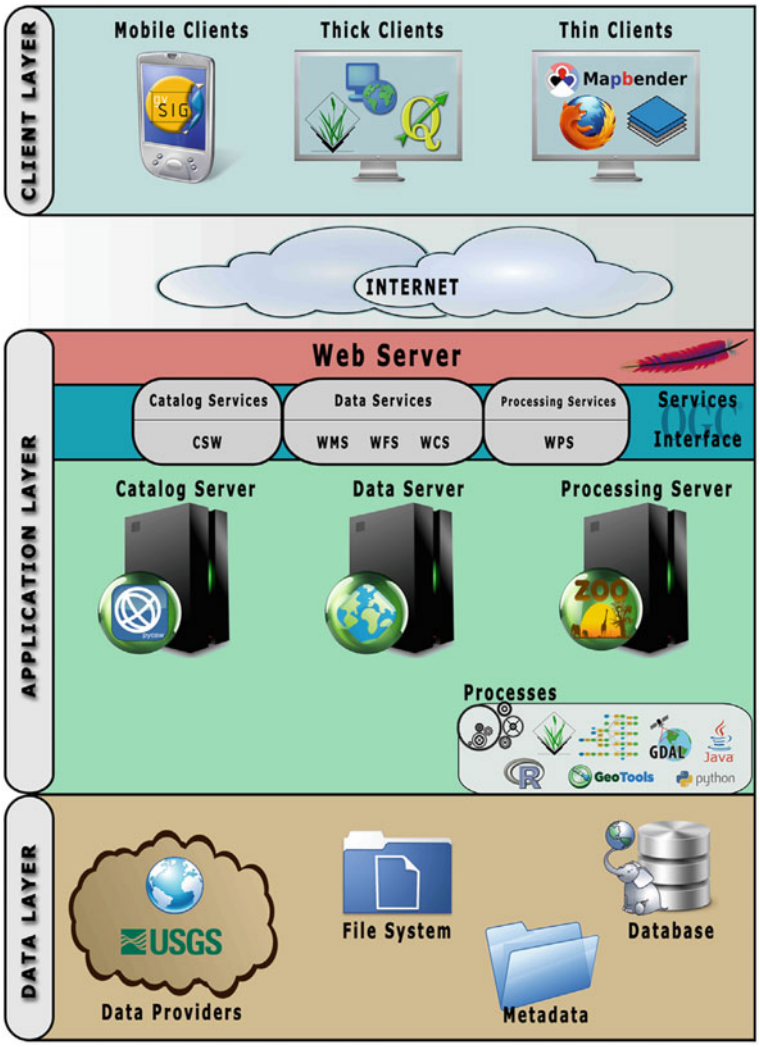

Fig. 1 System architecture for Cloud SDI Model

provision of a standard mechanism to assimilate different cloud applications in the software cloud with enterprise SOA infrastructure [19–23]. Figure 1 illustrates the system architecture for Cloud SDI Model [24].

It has been shown from the system architecture of Cloud SDI Model where geospatial database is a vital module in data layer in Cloud SDI Model. Thus, next section has been emphasized on the geospatial database creation.

3 Geospatial Database Creation

The creation of GIS digital database is significant & tedious assignment where efficacy in GIS project depends upon. Integrated geospatial database creation includes stages such as inputs of data on spatial and attribute and its authentication by connecting with same set of data.

Geospatial database delivers a platform in which organizations interrelate with technologies to nurture actions for spending, handling, and generating geographic data [25, 26]. The development of geospatial database supports in various administrative and political levels through these decision-making functions. Quantum GIS 1.6.0 and Map Window GIS 4.8 are two OS GIS software selected to examine the competences w.r.t. creation of geospatial database.

4 Aim of the Current Research Work

The aim of the current research work is to do comparative analysis of Quantum GIS and Map Window GIS which have been utilized for geospatial database creation and also broadly used for development of geospatial educational database. It has also proposed a robust step-by-step approach for the development of geospatial database with the help of Quantum GIS and Map Window GIS. Thus, the next section describes the comparative analysis of Quantum GIS and Map Window GIS.

5 Comparison Analysis of Quantum GIS and Map Window GIS

An OS GIS licensed under the GNU General Public License is Quantum GIS (QGIS). The formal assignment of Open Source Geospatial Foundation (OSGeo) is QGIS. It has been supported various raster, vector, and database formats. QGIS project was officially released in May of 2002 when coding began. It is a multiple stage application and executed on various OS like UNIX, Linux, Mac OS X, and Microsoft Windows. It can be utilized as GUI to GRASS and having trivial size of

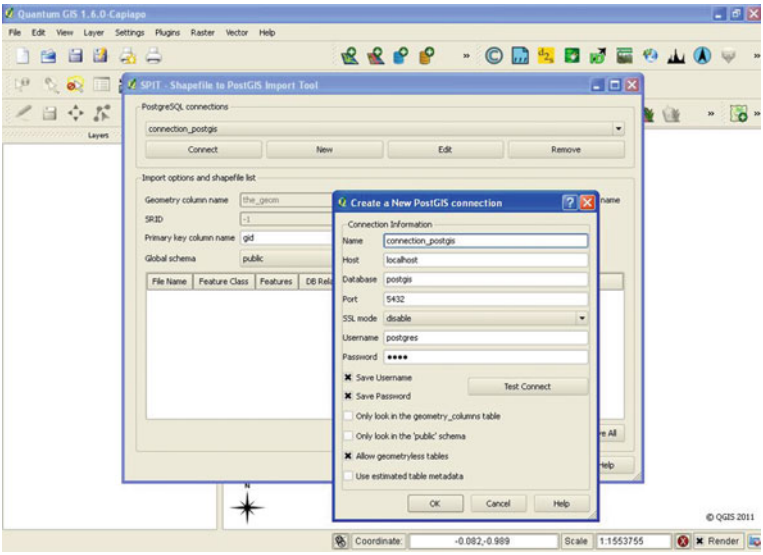

Fig. 2 SPIT plug-in tool

file in comparison with commercial GIS software. SPIT (Shapefile to PostGIS Import Tool) plug-in tool has been used in QGIS and can be used to load multiple shapefiles at one time and includes support for schemas. To use SPIT in QGIS, it needs to open the plug-in manager from the plug-in menu and check the box to the SPIT plug-in. Figure 2 shows the snapshot of SPIT plug-in tool with filed input box [27].

MapWindow GIS is an OSGIS software which has collections of programmable planned modules. It is adopted as the primary GIS platform for its BASINS (Better Assessment Science Integrating Point and Nonpoint Sources) watershed analysis and modeling software by the United States Environmental Protection Agency. It is purely developed under Microsoft.NET Technology platform. It includes plug-ins for several geoprocessing jobs like accessing online data sources, buffer and merge, watershed delineation, and an experimental geodatabase plug-in. Map Window GIS is provisioned with wide variety of data format and read/write ESRI outline records. The structures and aspects of spatial have been revised in accordance with the requirements for managing the database. Map Window GIS has also unique plug-ins 'Spatial Converter' to create geospatial database from excel datasheet. Spatial converter also has the features to import and export ESRI shapefiles from different file formats. Figure 3 shows the snapshot of spatial converter tool in which Excel file imported to create ESRI shapefile in point data [28, 29].

The following Table 1 has been summarized the analysis of two OSGIS in terms of various parameters associated with the user points of level.

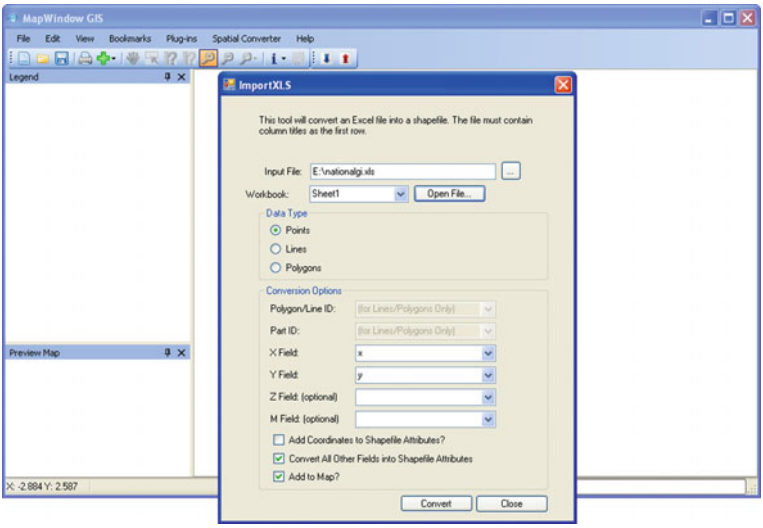

Fig. 3 Spatial converter tool

Table 1 Comparison analysis of quantum GIS and Map window GIS

Geospatial database creation software	Open source	Free software	Web	Linux/ BSD/ Unix	Mac	Windows	Other
Quantum GIS	Yes	Yes	Yes	Yes	Yes	Yes	Google Earth Plugin, KML, WMS
Map window GIS	Yes	Yes	No	No	No	Yes	No

From, the above comparison analysis, it has been considered to be used these two OSGIS software according to the user requirement and the platform which has to be demand for the development of geospatial database creation. Thus, the next section describes about the methodology adopted for the geospatial database creation.

6 Methodology Adopted for Geospatial Database Creation

For creation of geospatial database, the prime emphasis has been on the real-world approach to discover and spread the thought of geospatial database creation in academics sector. The established geospatial database has to provide a proficient means of allocation of geospatial and non-spatial data in Cloud SDI Model. The prototype is based on Object-Oriented Software Engineering (OOSE) proposed by

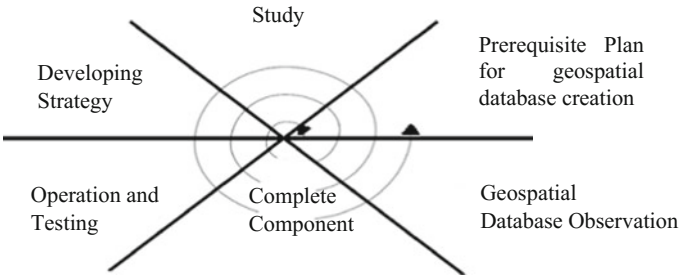

Fig. 4 Win-Win spiral model for geospatial database creation

Jacobson's method to combine the time critical nature and strong user focus [30, 31]. Figure 4 represents the fully win-win procedure model for creation of geospatial database creation.

The procedure model of geospatial database creation is recurring or frequent in nature and each operation improves the study and strategy steps through assessment and testing of a completed component. In complete component, Quantum GIS Open Source GIS software has set up an educational geospatial database by the help of political map of India. QGIS is also used for integrated geospatial database creation. The educational geospatial database has been nominated to illustrate the capabilities of developed framework. Geospatial database for educational sector has been prepared by Quantum GIS Ver. 1.6.0 and Map Window GIS Ver. 4.8.1.

Initially, the base image of India has been downloaded from the Google Earth. The downloaded image is geo-referenced with the help of Geo-referencer tool in Quantum GIS Ver. 1.6.0. For geo-referencing, the base map of India, 10 numbers of GCPs have been taken. The GCPs have been selected at the intersection of latitude and longitude lines. For universal coordinate system, WGS-84 with EPSG:4326 coordinate reference system has been chosen. Now, the image is ready for geo-referencing. After geo-referencing, the generated image is used to extract the thematic maps. Figure 5 shows the snapshot of geo-referencing of India map in Geo-referencer Tool from Quantum GIS Ver. 1.6.0.

In the present application case study, the entire technical institutes of Odisha have been taken. These have been categorized into the different layers with schema definition. Figure 6 shows the layer name with respect to schema definition.

After schema definition, six thematic layers have been created. First layer has been created which indicates the whole India state boundary. For this layer, WGS-84 with EPSG:4326 coordinates reference system has been chosen. India state boundary has been created by on-screen digitization process in Quantum GIS in ESRI shapefile format. The next two thematic layers have been created by Map Window GIS Ver. 4.8.1 with spatial converter tool.

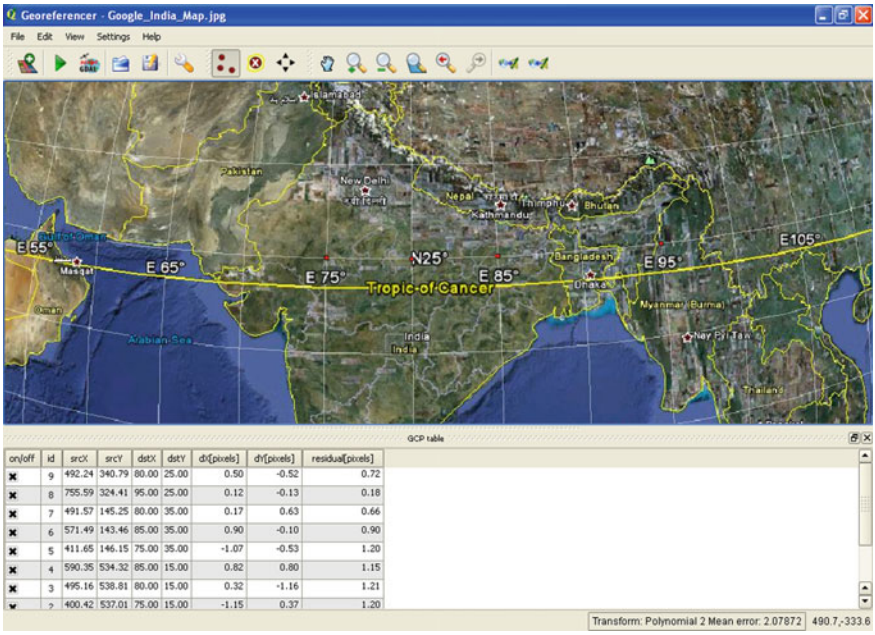

Fig. 5 Geo-referencing: Map of India

Technical Institute of Odisha

UID	Name	D_Name	D_Contact No	Website	State	Longitude (X)	Latitude (Y)

India State Boundary

UID	State Name	State Capital Name

Fig. 6 Schema definitions for educational geospatial database layers

From the spatial converter tool, two thematic layers have been generated, namely:

- Technical Institute of Odisha
- India State Boundary

Finally, these two layers have been overviewed with India State Boundary. Figure 7 shows the snapshot of two layers in Quantum GIS 1.6.0.

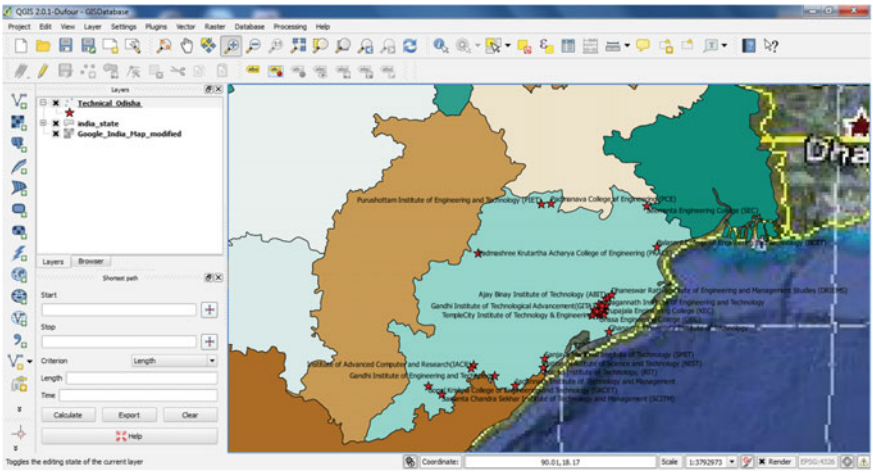

Fig. 7 Integration of educational geospatial database

7 Concluding Remarks

The current research work endeavors to link the information between the real merits and demerits of OS GIS software via comprehensive exploration & evaluation of particular aspects correlated with functionality and complete execution. It is recognized as competent for delivering vigorous proficiencies to form the geospatial database.

In regards to the creation of geospatial database, both Quantum GIS and Map Window GIS software invented as appropriate. However, the core emphasis of the current assignment is to cultivate the educational geospatial database particularly at state level, and further, it will implement for Cloud SDI Model. Therefore, the database which has been established is analytical and does not include complete structures. This database may be made more ample in forthcoming studies. Currently, it has been planned to extend for other state level and the equivalent may be deployed on the cloud environment in imminent studies.

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