Accessing OpenStreetMap as a Source of Village Geographic Information of Sri Lankan Administrative Systems: A Case Study Selected Districts of Batticaloa, Vavuniya and Gampaha in Sri Lanka

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Abstract

Based on the historical information and survey, there is a lack of geospatial data gathering and methods in the government bodies. Therefore, the study was carried out to introduce the Open Source applications to collect the field level information and create an online contribution of Village Geographic Information (VGI) through a community participatory mapping exercise. The geospatial data is essential for Sri Lanka due to various usages such as decision-making, identifying the flood inundation areas, risk assessment, water resource management, land use planning, innovative creating apps, 3D model and navigation. The study aims to analyze how far the role of OpenStreetMap (OSM), field papers, Maps.me, Java OpenStreet Map Editor (JOSM), Hot Task Manager and Preset to support collecting the geospatial data and developing the maps in *Vavuniya*, *Batticaloa* and *Gampaha* Districts. It's done by collecting geospatial data through a community participatory method using an Open Source Application. The data were collected through very simple approaches because of the advantage of Sri Lanka's administrative system and governance. Collected geospatial data were validated and verified by the government officers and evaluated the progress of the map development was based on the OSM contribution of contributors. Location-based and Administrative maps were developed through a community participatory mapping exercise. The OSM produced a user-friendly application of open source and GIS to develop complete geospatial data for three Districts which have been uploaded into the web-based portal, while, it can be accessed anytime, anywhere and by anyone for cost-effectiveness. The building footprint, road access, land uses and point of interest database were established using JOSM, Field Paper and Bing satellite imagery. It was updated with the building attributes produced by the data collection exercise. The developed online geospatial database in OSM is an important asset since it is supported by preparing village-level spatial information (service centres, roads and buildings), an emergency flood risk management plan, accelerate the emergency response and flood mitigation plan for the study area by the government.

Keywords: geospatial, community participatory mapping, openstreetmap, user-friendly

1. Introduction

Geospatial information depicts most details of the VGI, and Administration's limit in a particular area. It is supported to plan the administrative boundary mapping (Kanthi and Purwanto, 2016). The OSM has recognized the digital platform of the community-based map with natural and man-made features (Albrecht, 2020). OSM is a web-based GIS product that can also be used to access through the smartphone. The mobile GIS mapping process reinforces to edit, downloading and uploading of geoinformation based on the consent admin domain. It has popular data sources increasing use in applications such as Wikipedia, Map Box, CartoDB, Field Papers, Maps.me, JOSM, HOT Task Manager and Foursquare (Sehra et al., 2014). Recently, different studies have incorporated OSM with Remote Sensing images for mapping in urban areas (Justiniano et al., 2022). However, the OSM project had almost 4.7 million users, contributing almost 6.2 billion Global Position System (GPS) points and 514 million lines, which are partially based on 4.6 billion notes and 5.9 million relations that have been uploaded (OSM stats, 2018). It is a tool for open-source spatial information such as OSM, JOSM and GPS with Field Papers (Suthakaran et al., 2020). Using these tools, the collected information, to support several studies of village administrative boundary mapping by village people with local knowledge (Kanthi, 2016), urban studies (Goodchild, 2007), landscapes and ecologies of the tropical world (Ludwig et al, 2021), street networks (Arsanjani et al., 2015; Natera Orozco et al., 2019; Padgham et al., 2019; Liu et al., 2020), mitigating disaster risk in the novel scope of risk assessment (Zook et al., 2010; Suthakaran et al., 2020). OSM emerges to promise information sources through volunteer geographic information from the collaborative (Zook et al., 2010; Herfort et al., 2015; Yagoub, 2015; Mirbabaie et al., 2016), community mapping for urban planning (Suthakaran et al., 2020; Grinberger et al., 2022).

In Sri Lanka, the new terminology of open-source applications has been used to help communities in an organized way to collect geospatial data, which becomes the product of the surface (Suthakaran et al., 2020). It is the use of adequate methods and skills that support what has been called community involvement and empowerment (Herfort et al. 2021). However, modern technology is needed to develop spatial information in developing countries (Kaleel and Zahir, 2016). Suthakaran et al. (2018) argue that the local spatial maps are insufficient to create a detailed map with updated information on Sri Lanka. The updated maps are essential in many areas in Sri Lanka, especially to establish a standard of spatial information at the village level. The periphery of the administrative system is emphasized to distribute the resources which are very convenient for the community to deal with administrative level for public services (Pasi et al., 2015). Thus, OSM is advantageous to developing the geospatial database through government organizations for improving village information in the study areas. Therefore, there is a timely requirement of building detailed maps across the country using OSM to help with future development. This study aims to explore the possible method of collecting geospatial data from selected three districts of *Batticaloa*, *Vavuniya* and *Gampaha* to build resilience and model to develop in the OSM platform nationally through community-based participation. Therefore, the selected Districts establish an OSM platform for development and the vulnerable area for flood hazards. The wide-ranging geospatial datasets are required to handle development activities and disaster-related events through community participation. However, communities are the principal responders in case of development and disaster events. While it also requires

the use of new or recently adopted technology with information and parameters modified to the local context, resources and other needs. The OSM platform has been developed to bring the power of community mapping to support urban planning and disaster management investment.

2. Materials and Method

2.1 Study Area

Vavuniya District is located in the Northern Region of Sri Lanka. It is situated central of the Northern region bounded by *Mannar*, *Mullaitivu*, *Killinochchi* and *Anuradhapura* Districts. *Batticaloa* District is located on the Eastern coast of Sri Lanka and consists of a flat coastal plain which consists of approximately 2,610 Km^2 (Statistical Hand Book, 2021) and with an elevation between 1.2 - 15.0 m Mean Sea Level (MSL) with an undulating plain between 5 to 50 m. As well, *Gampaha* District is located in the western region of Sri Lanka *(see Figure 01)*.

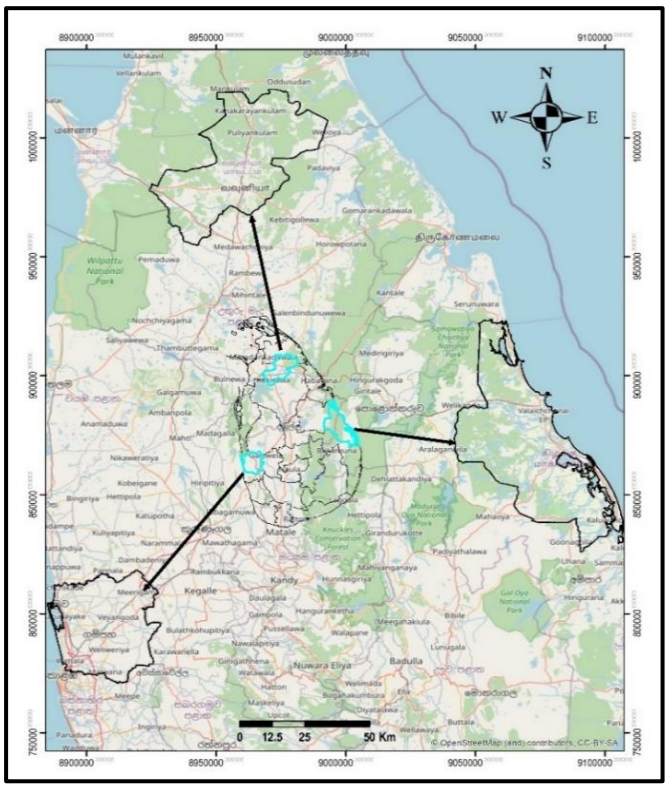


Figure 01: Study Area

Gampaha district has a second-order city in the western province (UDA, 2018) which represents the polycentric urban form where all administrative, commercial, educational, recreational, health and judicial services are agglomerated.

2.2 Gathering and Organizing Spatial Data

The first part of the study focused on the use of the Community-based Participation Approach (CPA) to introduce open-source applications and methods to collect and update village-level geospatial data, especially for building characteristics, points of interest and road accessibilities *(see figure 03)*. The village-level updated spatial data were verified by the government officers and prepared the datasets for preparation of the village-level map for utilization by the government for their day-to-day activities. GIS-based open-source applications with mobile apps were introduced to identify the potential area for future developments. Secondly, the study used the population data to analyze the population distribution, compare the building pattern and the utilization of community participatory mapping exercise.

This study used free and open-source geospatial software, applications and mobile apps to collect the geospatial data in the selected Divisional Secretariat Divisions of the three districts. The qualitative

geospatial data such as the standing of buildings, materials, and storage and roof types while the number of buildings for the quantitative information. These methods were used to collect field and administrative levels of information to enable the distribution of buildings, land uses, and infrastructures and find out the challenges to practicing new technologies at the district level *(see Figure 02)*.

National Housing Development Authority, Batticaloa Municipal Council, Disaster Management Centre (DMC), Sri Lanka, District Secretariat (Batticaloa, Vavuniya and Gampaha) and the community to expose data collection methods to find the building characteristics from each household by using questionnaires forms in the village adopted the CPA. The training was provided to field-assigned officers by the Training of Trainers (ToT), it was useful to read the map, find landmarks in the field papers and locate buildings on the field paper, and validated with ground truth data collection. Furthermore, JOSM, QGIS, and Hot Task Manager were used to trace building footprints by digitizing for updating the GN Boundaries and other necessary information from the village level.

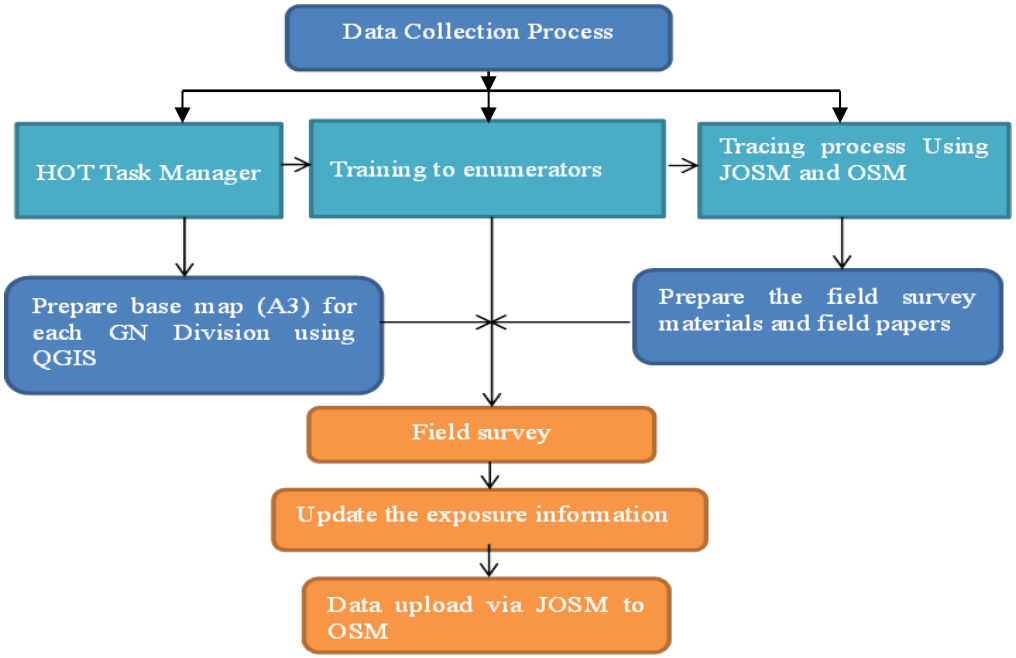


Figure 02: Flow Chat of OSM Data Collection and Update

Furthermore, the secondary data was used from the District disaster management plan, a comprehensive land use plan, a statistical profile of the districts, a committee and village disaster plan and relevant maps.

Figure 03: ToT and OSM Updating in *Batticaloa, Vavuniya and Gampaha* Districts in 2020 and 2021

In addition, the study has introduced the volunteer contribution in open source applications to collect exposure information in the three Districts. Especially in *Vavuniya* District, DMC *Vavuniya* District, *Vavuniya* South Divisional Secretariat Division (VSDSD), and the Department of Agrarian, *Vavuniya* was voluntarily involved in fulfilling digitization for geospatial information of the entire District *(see figure 03)*.

Earth surface observations can be updated through public participation such as experienced people, critical thinking, and knowledge of expertise, which were a very effective manner to obtain data on the ground. Sri Lankan's administrative structure has a diverse range of economic development officers and *Grama Niladhari* (GN) officers, which enable to get spatial information with public participation. The process of identifying the location, collecting geospatial database and community knowledge was used through the intensive use of several participatory tools such as in-depth interviews, focus group discussion, and transect walk. The main theme is as follows:

i. Land use changes are experienced in terms of type, infrastructure, built-up area and duration.

ii. Verify the exposure data, point of interest and restricted area.

iii. Mapping exercises were developed to be aware among the community.

iv. Use of resources available at the DS level

2.3 Data Extraction and Validation

Geospatial data was exported through the open-source web-based application (https://export.hotosm.org/en/v3/exports/new/describe) in the shape (.shp) file format *(see Figure 04)* and used this data for analysis. The process of data export was as follows:

i. Browse the hot export web-based application
ii. Find the study area and export it

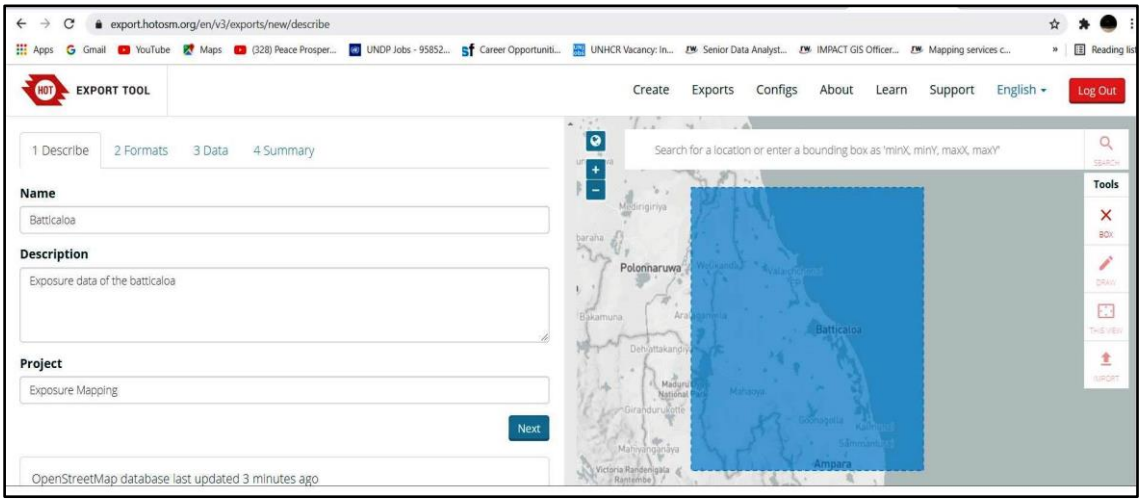
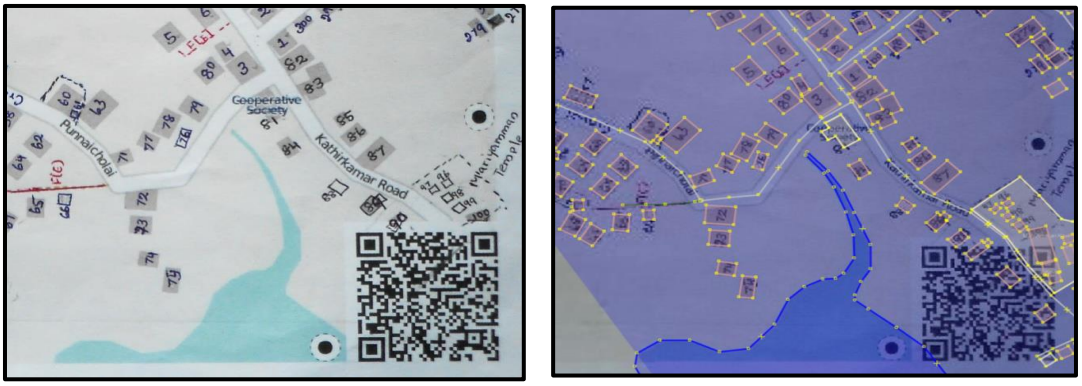


Figure 04: Open Source Web-based Application for Exporting the Data from OSM Server

Validation errors through reference tutorial spatial data handling intermediate, the advanced editing technique will be validated the spatial data through the Humanitarian OSM Team of Sri Lanka. The validated data can be used according to the norms of the OSM (Zhou et al., 2014).



(a) (b)

Figure 05: (a) A Field Paper with Missing Buildings Located with the QR code, (b) Matching area with Buildings at the JOSM Interface in *Vavuniya* District

When inspection checking for conflicts of geometry and attributes, the map avoids conflict because no editing of the same area at the same time *(see Figure 05)*. However, a preliminary examination of the geometry and attributes will show there is an error, warning, or no error. While errors occur due to incorrect, attribute features that will warn incomplete data and confusion data.

3. Results and Discussion

The OSM platform has updated the maps that can be obtained free of charge for public utilization by the web portal. Here, the OSM provides a user-friendly environment to edit and update for users while it provides data attribute that can be processed after export to the .shp file format. When doing digitization, the higher resolution image can be recommended with true color composite where the map feature results

will be in higher accuracy. The digitized features include points, lines (roads and rivers) and polygons (buildings and land use) *(see Figure 06- 09)*.

(i) (ii) (iii)

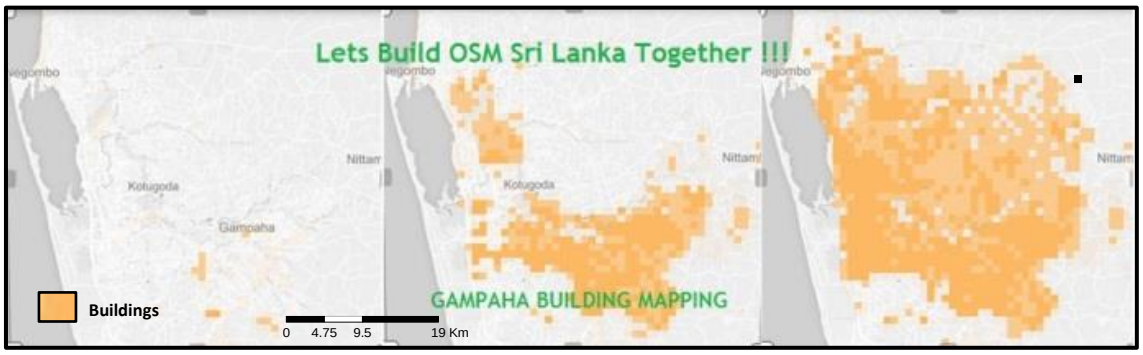


Figure 06: OSM Public Participatory Map of *Gampaha* District, (i) 2014; (ii) 2015 and (iii) 2020

However, the maps have provisions that cover the content of the information at the regional level, which is based on the norms, standards, procedures and criteria. It must be present on the map including topography, administration, infrastructure, hydrography and land use.

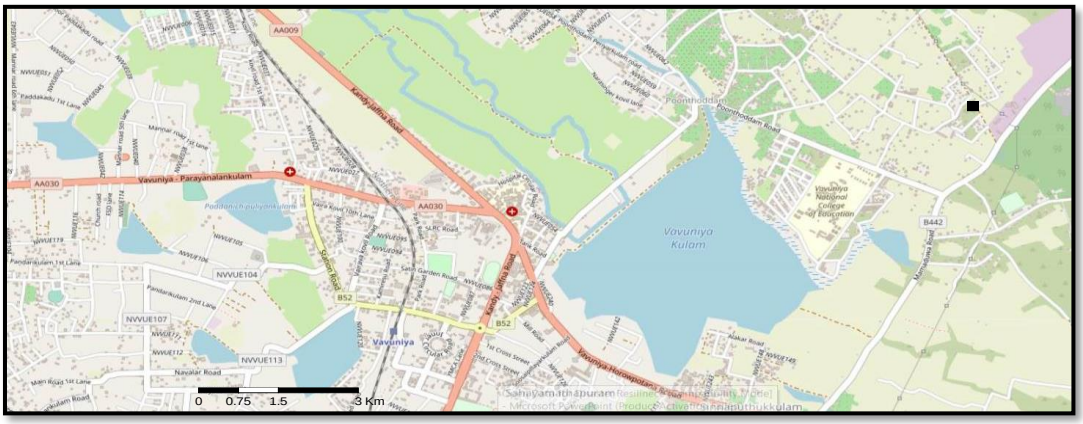


Figure 07: OSM Public Participatory Map of *Vavuniya* District in 2021

Village Geographic Information (VGI), OSM and community participatory data collection methods were combined with GIS that useful approach to improve the understanding of the community involvement to use and handle the OSM and open-source applications in the study area. The integration of local knowledge in GIS-based methods could interpret different aspects of geospatial distribution. In addition, it has expanded the understanding of how the changes are appraised by residents of these existing settlements and local villages in their daily lives.

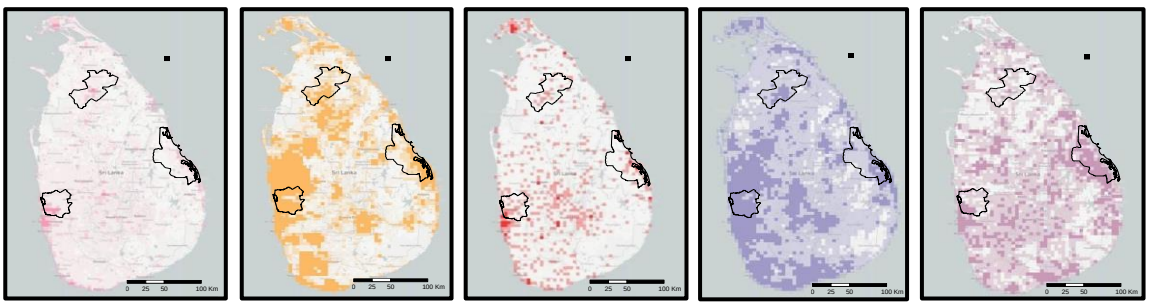
(a) (b)

Figure 08: OSM Public Participatory Map of *Batticaloa* District, (a) 2nd May 2013; (b) 10th October 2022

OSM is permitted and simple to use and it can generate, edit, and share its spatial data with OSM contributors (Suthakaran et al., 2022). The contributors create, edit and update to extract surface data as a spatial Open-source map such as building types, number of floors, roof type, roads, water bodies (rivers, tanks and ponds), vegetation, and other points of interest. At present in Sri Lanka, the results traced several buildings, roads, rivers, amenities, and hospitals that recognize the sustainable development of the nation in order to the public participation of OSM web-based VGI. The features have been updated as a spatial dataset in the OSM web portal by till now approximately 5,039 contributors who collaborate in Sri Lanka *(see Table 01)* and it can be accessed through the https://osm-analytics.org/#/ web portal of OSM for open-source VGI which information could manipulate for the feasible study of sustainable development in Sri Lankan context.

Table 01: OSM Spatial Dataset in Sri Lanka

Features	Coverage	Contributors
Building	2,415,060	2,271
Roads	129,926 km	1,078
Rivers	18,759 km	342
Amenity	26,406	1,130
Hospital	761	218



(a) (b) (c) (d) (e)

Figure 09: Public Participatory Mapping of Sri Lankan Administrative, (a) Amenity; (b) Buildings; (c) Hospital; (d) Roads; (e) Streams

4. Conclusion

The OSM is a geo-informatics application integrated with GPS, Web, Mobile and satellite images. The online geospatial database is available to everyone and can be updated by interested OSM users, which are based on the norms, standards, procedures and criteria for the regional mapping part. It is an open-source VGI in terms of inputting, editing and exporting spatial data in a user-friendly environment for spatial information. It can be used to plan to make the process sustainable ways whereas devising a monitoring mechanism in the *Batticaloa*, *Vavuniya* and *Gampaha* Districts. The OSM information provides village-level geospatial information integrating with maps for physical development and can plan to mitigate the situations of emergency response such as floods, drought and fires through the digital format of shape and KML file formats in the three districts. Therefore, the OSM can be a good alternative solution for village-level spatial information such as buildings, roads and service centres.

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