Application of Open Street Map and Geo Spatial Techniques in Disaster Exposure Mapping: Attanagalu Oya

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Abstract

Geospatial Techniques are essential components for building smart cities in a basic way that maps the physical world into virtual environment with the concepts of mitigation, adaptation of disasters and their risks. Over 165,000 households in. the Attanagalu Oya River Basin and its environs are vulnerable to risk of flooding and inundations. The damage of property, loss of lives, deterioration of the eco systems were some past adverse impacts of the floods. In order to assure the disaster resilient environment of the selected area, the Open DRI Sri Lanka team is creating OSM data from satellite data which is named as bing and world view. Java Open Street Map(Josm), QGIS, GPS Essentials, Open Map Kit are the tools and techniques used in disaster exposure mapping process. All buildings, roads, streets and other exposed assets were surveyed and inventoried using the open street map platforms. The geo spatial techniques combine with diverse steps of process. The creation of Open Street Map Accounting, Selection of Task Manager, digitizing with JOSM, use of Field papers, GPS tracking of roads are the associated steps of disaster exposure mapping. The local, national government bodies and international parties were engaged in the process. The exposure Mapping entitle with the major challenges of less mappers. Word of OSM has not been spread, Lack of recent clear high resolution satellite images, Less media attention, Deliberate or unintentional damage, No knowledge about direct usage of the map, Cost of internet. Initially the disaster managers contribute to identify the flood prone areas and mitigate the floods with the real time disaster modeling and response planning for the betterment of the people and the environment.

Keywords: Geospatial Techniques, Disaster Exposure Mapping, OSM data, Java OpenStreetMap (JOSM), QGIS, GPS Essentials, Open Map Kit, Disaster Modeling

1. Introduction

Open Cities is part of the Open Data for Resilience Initiative, sponsored by the World Bank and GFDRR. Open DRI brings the philosophies and practices of the open data movement to bear on the challenges of building resilience to natural hazards and the impacts of climate change. In partnership with governments, international organizations, and civil society groups, this initiative develops open systems for creating, sharing, and using disaster risk and climate change information to ensure that a wide range of actors can participate in meeting these challenges. Since its launch in 2011, Open DRI has worked to implement these ideas in over 25 countries around the world. Gampaha which is selected as case study area has been declared as an Urban Development Area on 20.02.2001 under the gazette notification no 1172 -7. The recent Colombo Metropolitan Regional Structure Plan has identified Gampaha as a second order city in the western province.it is the core of Gampaha district and it represents the polycentric urban form where the all administrative, commercial, educational, recreational, health and judicial services are agglomerated. Gampaha Development Plan has identified a set of projects as priority projects to exist the poly centric urban form with city beautification and provide the better services for the users by suiting the urban development trends. Although Gampaha is being in locational potential & future development scenario of the proposed central express way the area is exposed to the floods and the assets are under the disaster. The study helps to find the number of assets and the land uses under the disaster.

1.1. Problem Statement

The research problem was formulated as '*How does the Geo Spatial Technology affect to identify the assets of the disaster exposure?'* Gampaha Divisional Secretariat area was selected as a case study, this study intends to open up the geo-based tools for the disaster exposure mapping and show the magnitude of the assets at the disaster with the all typologies.

1.2. Objectives

This study has three major objectives that will explore the number of assets in flood disaster exposure around the Attanagalu Oya River basin to find the building characteristics as it is related to community disaster resilience. It will further assess the disaster exposure of the individual number of buildings in the selected area with the use of geo-based tools of GPS Essential, Open Map kit, QGIS, ODK. Secondly, the study aims to share the geo spatial knowledge with the professionals at the multi-disciplinary streams who are interested in applying the modern geo spatial tools in the diverse tasks of the profession. Ultimately the study opens up a geo spatial platform for the volunteers and the users for the digitizing tasks and identification of the disaster prone areas.

1.3. Scope & Rational

Attanagalu Oya River Disaster Exposure Mapping Project was formed as a part of the World Bank's Open Data for Resilience Initiative (Open DRI). Attanagalu Oya River plays a major role in the national water supply in this region of Sri Lanka since it contains the major national water supply and drainage board intakes. The recurrent flood disaster incidences associated with the river basin prompted this Project to map the flood inundation areas in the Ja-Ela, Katana and Gampaha Divisional Secretariat Divisions to support disaster risk reduction initiatives in the country. This was further broken down to 162 Grama Niladhari Divisions (GNDs) and 116,000 housing unit were identified as the Project scope where digitizing, surveying, validation, analysing and preparation of maps in thematic area of buildings, roads/streets, and other exposed assets in the given area and surveyed and inventoried using the OpenstreetMap platform. In parallel a beta version of a data sharing platform called Riskinfo.lk was established, and several technical workshops and outreach initiatives with the Government, the academia and the civil society were conducted.

2. Literature Review

The inception of Open Cities has brought together stakeholders from government, donor agencies, the private sector, universities, and civil society groups to create usable information through community mapping techniques, to build applications and tools that inform decision making, and to develop the networks of trust and social capital necessary for these efforts to become sustainable. This process has been evolutionary, with opportunities for experimentation, learning, failure, and adaptation incorporated into the project planning. The rationale and design of the Open Cities Project launched its efforts in four cities of Batticaloa, Gampaha, Dhaka and Kathmandu Cities as the major components of its implementation of the project.

South Asia is one of the most rapidly urbanizing regions in the world. A deep understanding of the built environment is critical to providing relevant services, managing urban growth, and visualizing disaster risk in this context. For example, good characterization of the built environment allows urban planners, engineers, and policy makers to plan for and design appropriate transportation systems and adequate water supply systems to estimate the population distribution of cities and attempt to manage the urban sprawl and to identify the potential sites for parks and public services. In addition, growing population, unplanned settlements, and unsafe building practices all increase disaster risk.

Mainly the Government support and the participation in an Open Cities mapping project is a key strategy for ensuring its sustainability. The OSM community is also an essential resource, along with other partners such as universities, civil society organizations, and the private sector. This subsection examines these likely partners and their potential roles in disaster exposure mapping.

In Sri Lanka, Open Cities has focused on the city of Batticaloa, Gampaha which is affected by flood as well as potential for hurricane and storm surge. The initial stage of the project, there weren't available resources to map the entire at-risk area so in consultation with government partners, Open Cities started a pilot project to map all the buildings and roads in the Manmunai North Divisional Secretariat (DS) that covers an area of 68 km2 and about 90,000 people. Further the project was launched to Gampaha Divisional Secretariat Division area. As urban population and vulnerability grow, managing urban growth in a way that fosters cities' resilience to natural hazards and the impacts of climate change becomes an ever-greater challenge that requires detailed, up to date geographic data of the built environment. To meet this challenge requires innovative, affordable, precise, open, and dynamic data collection and mapping processes that support management of urban growth and disaster risk.

Open Cities approaches risk assessment differently from catastrophic risk modelling firms, whose data

are typically used either for broad awareness raising or for the insurance industry. These professional assessments often involve computationally intensive modelling analysis, but they also tend to rely on statistical representations, proxies, or estimations of the exposed assets, which are expressed in monetary terms. Such data are insufficient for driving specific investments to reduce disaster risk because they typically do not locate, describe, and value individual assets. Specificity on a project can be enumerated if certain priorities have identified the need to focus on mapping a certain type of object or structure. These decisions might centre on mapping the structures of greatest vulnerability.

3. Approach & Methodology

3.1. Data collection

The data collection has been done basically into primary and secondary. The primary data collections were carried out by the field survey, observation, GPS tracking and web base open source mapping software, mobile apps and tools ODK collect, JOSM, filed papers, GPS essential and QGIS were used with the support of Grama Niladhari & Development Officers.

As a primary data collection method, field survey carried out in 162 Grama Niladhari Divisions involving the Junior Mappers with the assist of respective Grama Niladhari and Development officer of each Grama Niladhari Divisions. Opens source maps were used to extract the surface information such as type of the buildings, number of story, roof type, roads, water bodies, vegetation, and point of interest. JOSM, filed papers, GPS essential and QGIS were used as open source software and mobile apps as such ODK collect used to collect the buildings characteristics and spatial analysis to prepare hazard map, vulnerable map and Risk map. The primary data collections were carried out as an integrated data collecting process that was continuous and proceeded through the several mapping tool kits as mentioned above.

In principally, Secondary data collection were involved with the consultation of 'Grama Niladhari' and Development Officer in each Grama Niladhari Divisions and Disaster Management Centre supported to coordinate with Grama Niladhari and Development officers of each GNDs. World Bank given the financial and technical support to carried out the exposure mapping Project and other related surveys, etc.

The data, Survey department of Sri Lanka such as existing land use layers and the flood maps data from the Disaster Management Centre and "Sampath pathikada" of the each Grama Niladhari Divisions were used as the Secondary data sources.

3.1.1Field Survey

162 Grama Niladhari Divisions were divided into 08 Junior Mappers and it was carried out with the support of all Grama Niladhari and Development Officers in the respective Project Area.

3.1.2. Data Entry

The primary data collections were carried out filling the questionnaire form. The questionnaire form developed by the project team as in convenient to use at the field and to work efficient and accurate. Due to the questionnaire form and its arrangement, data updating task became more convenient.

3.1.3. Data Validation

The data validations were done incorporation with technical assistance by the Disaster Management Centre and the World Bank.

3.2. Primary Data Collection Methodology

3.2.1. Task Manger

The first step of the primary data collection is creating a task manager for what user wants to edit and contribute to make the maps. The creating a task manager through https://tasks.hotosm.org/Join and user can work on the humanitarian mapping projects by taking a task. Worldwide have access to free and editable OpenStreetMap to address the local development challenges and aid disaster response. During working on the task manager, user can see the progress of overall project completion, etc, the tasks in progress, and can check the quality and accuracy also can validate the edits of task.

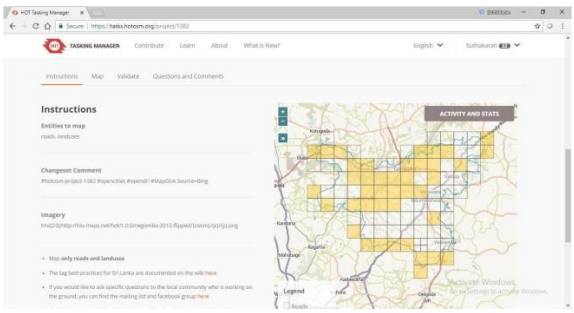

Figure 1: Hotosm Task Manager

3.2.2. Java Open Street Map (JOSM)

The second step of the primary data collection process is editing the task through OSM data which directly can be linked into the JOSM, the open source mapping software or JOSM can be itself used to trace the building footprints using JOSM and Tasking manager.

JOSM is an open source extensible mapping flat form that support GPX tracks, OSM data, imagery data from local sources as well as from online sources and allows to edit the OSM data as in nodes, ways, and relations.

The very first task of updating exposure mapping activity is tracing the building and road layers using JOSM.It is a fairly challenging task to accomplish, because large number of building footprints and roads need to be traced within a short period of time.OSM Tasking Manager http://tasks.hotosm.org used to divide the tasks among individuals as at Project's convenient. It's a Web based - mapping tool to split the mapping area into small areas, mappers can select an area and work on it. It avoids task duplications and allows a user with OSM ID to edit and validate.

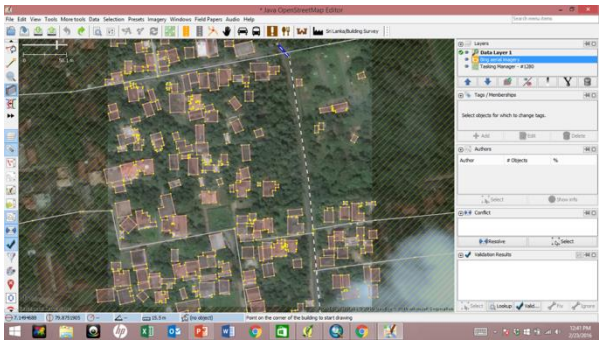

Figure 2: Tracing the Building Foot prints and Road Layers

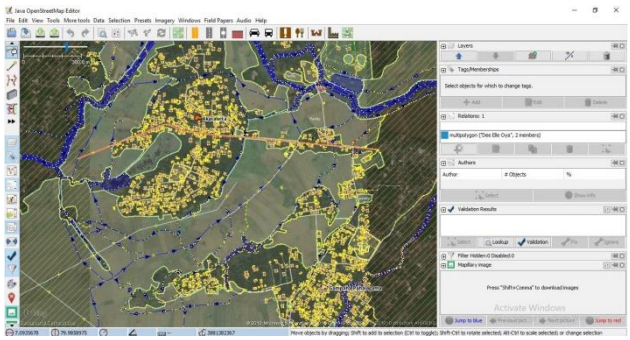

Figure 3: Tracing the Building Foot prints and Road Layers

Mappers can select a task by log in with a valid OSM ID. A selected area in Tasking Manager can be easily editable with JOSM. End of the data updating process, JOSM allows updating the traced data into OSM database. A mapper with experience can re-check the edits of other users and then can validating their tasks also.

Once finalized the digitized the data as buildings, land use and roads, Mappers can commence the field survey to update the point of interest into map and to increase the OSM information and ensure those in accuracy using GPS tracing.

Update of point of interests carried out through the printed format of the same data uploaded to the OSM. It carried out along with GPS tracing the roads. Most of the key facilities tagged into OSM database based on the secondary data from the Grama Niladari Divisions. Further some facilities were updated with the ground knowledge of the mappers, Grama Niladhari and Development Officer and communities.

3.2.3. Field Papers

The third step the primary data collection process is field papers http://fieldpapers.org/compose#2/25.2/66.3, it is one of the primary data collection tool applied in this field survey.The Field paper is an open source mapping tool. it can facilitate the user to produce the new field papers and upload, watch the maps that can be download anywhere in the world.

It comprises the details of OSM in a printed sheet. It is a web-based tool for easily creating a printable map atlas to print and add notes to. It allows the mappers to update the buildings and roads on a printed map; later during updating process users easily update the information using QR code. Field Papers allow easily format the page layout for a multi-page paper atlas with OpenStreetMap.

Field Papers gives the privilege to the user to decide how many splits can be made to prepare separate maps. During preparation of survey materials each Grama Niladhari division has divided into reasonable squares to ensure Mappers can access the detail of each data on the map.

Thus, field papers are the most convenient and efficient way of collecting exposure data and information. Once the paper records as user's requirement, it can be used as a printed map to record notes and observations about the survey carrying-on. Also it provides access to the new maps updated.

User can upload used field paper as photo into Field Papers.These photos are called snapshots.It's linked automatically to the world map from where it originated. Further, field papers facilitate the user to share the notes made in the field for later analysis and the works.

During the field survey Grama Niladhari and Development officer asked to give a number for each building appeared in the field paper and it is a major responsibility to maintain a questionnaire for the specific building with the same number.Incase if that building is not available in field paper, they have drawn manually it with a building number.

Figure 4: Creating Field Papers

Prior to the field survey, printed base maps for each GNDs, Questionnaires and XML, ODK file, GPS essential and Open Map Kit were installed in tabs and questionnaires were ready with the Mappers that could be more useful to identify the exact ways and points also gave a clear picture and understand in survey area.

Building Characteristics Survey

Map Id:

1. General information:

1.1 References
Map Building ID

1.2 Name: ..... (Only for public places or special places)

2 Building Category:

Residential		Government		Other	
Commercial		Utility			
Industrial		Abandoned			
Hospital		Under construction			

3 Amenity (building type) – skip when residential

Temple/ Other religious place		Bank	
Church		Restaurant	
School		Community Center	
Office Building		Clinic	
Shop			

4. Number of Stories: .....

5: Building Material:

Plaster		Wood		Glass	
Brick		Clay wall		Roof without wall	
Cement Block		Tin		Other	

6: Foundation Height (feet):

Less than 1		1.5 to 3	
1 to 1.5		More than 3	

7. Roof Material

Tile		Tin Sheet	
Asbestos		Cadjan	
Concrete		Other	
Permanent Zinc Sheet			

8. Roof Shape

1 Face (Lean-to)		4 Faces (Hipped)	
2 Faces (Pitched)		More than 4 faces	

Figure 5: Questionnaires for Building Characteristics

The idea behind the provision of Base Maps is to help the mappers with some information of known features. It can be a reference, when mappers have poor idea on the elements of field paper or find the details in field paper. These maps were prepared using QGIS with Open Layers plugin, and Hot Exports used to rip the building data from OSM servers. GN boundaries referred from Survey department data. The Mappers prepared the base maps with using OSM image as a background and the GN boundary as the base.

3.2.4. Open Street Map (OSM)

The final step of the primary data collection process involves with the use of OSM. It used as a platform to build a database on survey data for the disaster exposure mapping. The nature of an open source application, it is free to use and user-friendly comparing other GIS applications available today. Through the Open Data Commons Open Database License 1.0 can be access to the official OSM web site through www.openstreetmap.org. Open Street Map (OSM) contributors can, make and modify own and share data publicly. With OSM both the maps and

underlying data can be downloaded for free.Online registration required to use the free data and it is the first step of data collection process of OSM.

OSM data consists and it is able to edit as nodes, ways, relations, and tags.

a) A node is a single point with a latitude and longitude. A single node can be a point of interest such as a tree or a mailbox or a place such as a city or a village.
b) A way is a line. Lines are made by connecting many nodes together.A way can be a road, rail track or a trail.
c) An area is a way where the starting and ending point are the same. But, not all the closed ways are always areas. For an example a circular road would be a closed way but not an area. A lake, on the other hand, would be an area. Otherwise an area can be a shape or a polygon. Examples of an area include a building, a sports field, or a forest.
d) Relations are used to group geographically-related objects together. Relations could be used to group such roads of a bus route together. Easily can be developed a bus route instead of drawing a new set of ways, describing the roads which are needed to be a part of the bus route using a relation.

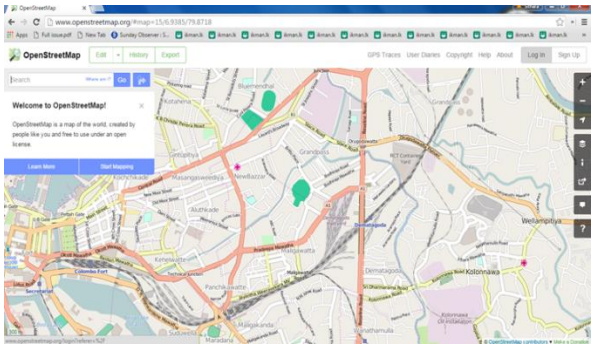

Figure 6: Online OSM data Editing

The user can data edit the data completing the registration accurately.

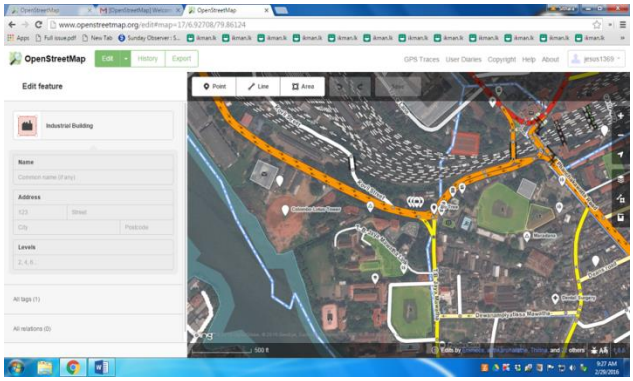

Figure 7: Open Street Map

A tag is a key/value pair that is used to describe an object. The key explicates that what kind of object it is, for an example an amenity or a highway. User can then grab the value to describe what type of object it is, for an example an amenity might be a bank or a pharmacy, while a highway might be a primary road or residential street. There are many tags already use in Open Street Map, but there is flexibility to create new tags in case what user wants to map out that nobody else has mapped before. This versatility means indicates that it is freely can add any keys and values that user think is to be needed. Many users/editors however have presets for common key/value pairs, which makes it easier and faster to edit maps.

Change sets are sets of edits within Open Street Map. Once the edit starts, the changes make during editing are saved in a change set. This change set can be seen in history tab of the map, and are associated with user account.

Final outcome of the process can be found as a completed spatial open source data base that can extend to produce the maps as user's requirements.

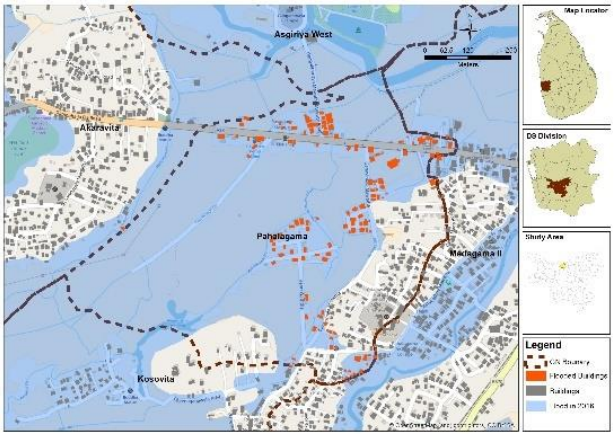

Figure 8: Sample Final Hazard Map

4. Findings & Results

The research enables to identify the magnitude of the flood prone areas of Gampaha Divisional Secretariat and the 165,000 number of actual households who affect for the flood exposure.The 165,000 numbers of households and the assets at the risk with the all typologies were inventoried with the use of modern tools of JOSM, Open Map kit, QGIS, and GPS Essentials. Further the research inaugurates to launch the geo spatial tools for the Sri Lankans to apply in the diverse professions.

5. Discussion & Conclusion

Gampaha is a first order city in western province with the major potentials, connectivity and transport network. Gampaha DS acts as a main administrative capital of Gampaha District. The initial studied carried by Gampaha DS has elaborated that Gampaha DS is vulnerable to disasters. The previous researches explore neither the actual statistics of the victims nor modern geo spatial tools in the disaster exposure mapping in Gampaha for the identification of flood risks.

This research elaborates the importance of the geo spatial techniques in the identification of disaster risk reduction and process of mitigation of the disasters. The key findings of the research contribute to activate the DRR initiative and the flood resilient plans to cope with the disasters in the Gampaha DS area and further it provides a basis for the application of the mentioned geo spatial tools in the disaster exposure in any area of the world.

6. Acknowledgement

Authors wish to thank the Gampaha Divisional Secretariat Office, the all participants and the World Bank to assist in the Disaster Exposure Mapping in Attanagalu Oya and open up an advance platform for Sri Lankans to familiarize the modern geo spatial tools for the disaster exposure mapping.

7. References

1. GFDDR(2018),New-Field-Guide-Explores-Open-Data-Innovations-Disaster-Risk-And-Resilience.Available from https://www.gfdrr.org/en/feature-story/new-field-guide-explores-open-data-innovations-disaster-risk-and-resilience. Accessed on 2018/12/07.

2. Harper, I., Ergas, H., Shaw, R., Simes, R., Matthews, K., McGinn, E. (2013). Building Our

3. Nation's Resilience to Natural Disasters. Deloitte Access Economics and Australian Business Roundtable for Disaster Resilience and Safer Communities, Kingston, ACT, Australia.

4. GFDDR (2018). Open Data for Resilience Initiative: Planning an Open Cities Mapping Project.

5. McGranahan, G., Balk, D., & Anderson, B. (2007). The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones. Environment and urbanization, 19(1), 17-37.

6. http://opencitiesproject.org.

7. https://tasks.hotosm.org/

8. https://learnosm.org/en/josm/start-josm/

9. https://wiki.openstreetmap.org/wiki/Main_Page

10. https://wiki.openstreetmap.org/wiki/Import/Guidelines

11. http://fieldpapers.org/

12. https://josm.openstreetmap.de/

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