IDENTIFICATION OF FLOOD AFFECTED AREAS AND PREPARATION OF BETTER MECHANISM FOR RELIEF SERVICES USING GIS TECHNOLOGY: A CASE STUDY OF WELIVITA AND MAHADENIYA GRAMA NILADHARI DIVISIONS OF KADUWELA DIVISIONAL SECRETARIAT DIVISION, SRI LANKA

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ABSTRACT

Flood is the major disaster type of Sri Lanka that effects on thousands of families in every year. Thus it is very important to identify affected areas and build a better mechanism for providing relief services to face such events effectively. Mostly in such events, relief services are provided without any proper identification of affected people as well as without any proper distribution planning. Thus, some affected people get fewer services while others are getting more. Most of the time non-affected people also get these services due to improper planning. This paper introduces a rapid practice to identify the flood affected areas and to prepare an effective planning to save victims and distribute the relief services using GIS Technology.
Welivita Grama Niladhari Division (GND) and a part of Mahadeniya GND of Kaduwela Divisional Secretariat Division (DSD) in the Kelani river basin were the study area that used to apply this method at flood event occurred in May 2016. Rapid field data survey was done using a hand held Global Positioning System (GPS) device to identify the maximum flood levels in selected locations. GPS height values and 1:10,000 data from Survey Department of Sri Lanka (SDSL) were used to build the 3D Digital Elevation Model (DEM) for generating 0.5m interval contour lines.
Total extent of 2.21sqkm area was identified as flood affected in Welivita and Mahadeniya GNDs. 977 houses were affected with people as well as 138 commercial buildings, 38 industries and 16 public and semi-public buildings were identified as affected buildings. Road network also was influenced by the flood, and affected length of the Class A roads was the 1,678m, and 391m length of Class C roads and 9,835m length of Class D roads were identified as affected. Non-affected roads use to find best routes to distribute goods for refugee camps, and land use data in the flooded area used to find best routes for boat services to save victims and provide facilities them. This information was used to provide a better service for the affected people very efficiently and effectively.

INTRODUCTION

Flooding from surface water, groundwater, rivers, estuaries and the sea pose a serious threat to millions of people around the world. It is likely that risks are rising and will continue to rise as a result of climate changes. According to the report of “Sri Lanka National Report on Disaster Risk, Poverty and Human Development Relationship, 2010”, number of flood events have been increased from 2003. Floods have caused the greatest damage and destruction to all types houses from 1974 to 2006. Flood is a major natural disaster type of Sri Lanka that effects on thousands of families, properties and the wider environment in every year. Figure 01 shows the ground reality with affected people and properties in the affected Area. Most difficult work was to identify number of housing units within the flood affected area. This paper helps to identify affected buildings by building usage, poverty level, and to save lives of affected people who required support services effectively. After identification of affected areas, it is important to use for planning, identifying better locations for refugee camps and to provide better relief services in a transparent manner. Thus, it is very essential to build a better mechanism of relief services to face such events very effectively. Mostly in such events, relief services are provided without any proper identification of affected people as well as without any proper distribution planning. Thus some affected people get fewer services while others are getting more. Sometimes non-affected people also get these services due to improper planning. And also service providers face to difficulties when they are proving services in unknown areas to unknown people.

Therefore, this paper introduces an effective and scientific approach to identify the flood affected areas and to prepare an effective planning to save victims and distribute relief services using Geographic Information Systems (GIS) technology. GIS technology is used as a tool to analyze spatial data such as building data, transport network, places of interests, contour lines, and land use while building relationships among different spatial data. It is easy to get better decisions using updated spatial data for managing relief services within affected areas. Preparation of spatial data and relevant database in disaster risk areas is not an easy task. Therefore relevant authorities can play a bigger role to keep their spatial data up-to-date.

Figure 01: Ground reality, affected people and properties in the area.

With the development of the computer based GIS technology, it is required to move to the digital era to build the smart city concepts for developing the country. So, digital spatial data can be used in different ways to identify disaster proven areas, risk identification, mitigation, planning and resettlement with providing better services for displaced people. Mobile / web based technologies can be applied to see the real situation of the ground, workforce optimization and to operational awareness. This GIS technology can be applied in flood disaster management to identify the affected areas and to prepare transparent mechanism for relief services.

STUDY AREA

Welivita GND and a part of the Mahadeniya Grama Niladhari Division (GND) of Kaduwela DSD were the study area that uses to apply this method at flood event occurred in May 2016. Welivita GND is bounded to Kelani River, and both GNDs are located in the Kelani River basin. Extent of the Welivita GND is about 1.96sqkm, Mahadeniya GND is about 2.40sqkm, and the total area is about 4.36sqkm. Population information of above two GNDs is given bellow Table 01 according to the Department of Census and Statistics, 2011 data.

Table 01: Population Statistics

Description	Welivita GND	Mahadeniya GND
Extent (sqkm)	1.96	2.40
Number of Housing Units	1,186	1,398
Total Population (Year 2011)	4,962	5,470
Male Population (Year 2011)	2,397	2,681
Female Population (Year 2011)	2,565	2,789
Age bellow 15 years	1,281	1,365
Age between 15 – 60 years	3,086	3,464
Age over 60 years	595	641
Electricity Users (Housing Units)	1,162	1,367
Kerosene & Other Users (Housing Units)	24	31

Study area is a populated urban area and also not a hilly area. Old High-level road, Colombo – Ratnapura Road (AB 10) is running parallel to the Kelani River and the distance between the river and road is varying from 200m to 500m. The Figure 02 shows the geographic location map of the study area. Main land use types of the study area are Residential, Wetlands, Paddy, Coconut and Commercial. Study area is located in the wet zone and the average annual temperature is varied from 27 to28°C (81 to82°F), annual average rainfall is 2,404 mm (94.6 inches). The wettest month is May with an average of 382 mm of rain.

OBJECTIVES

Main objective is to identify disaster area and provide relief services in a transparent manner for refugees. Other objectives are to prepare a spatial database of the study area to provide post disaster services such as cleaning items, medicine, identify damages and support refugees to rebuild.

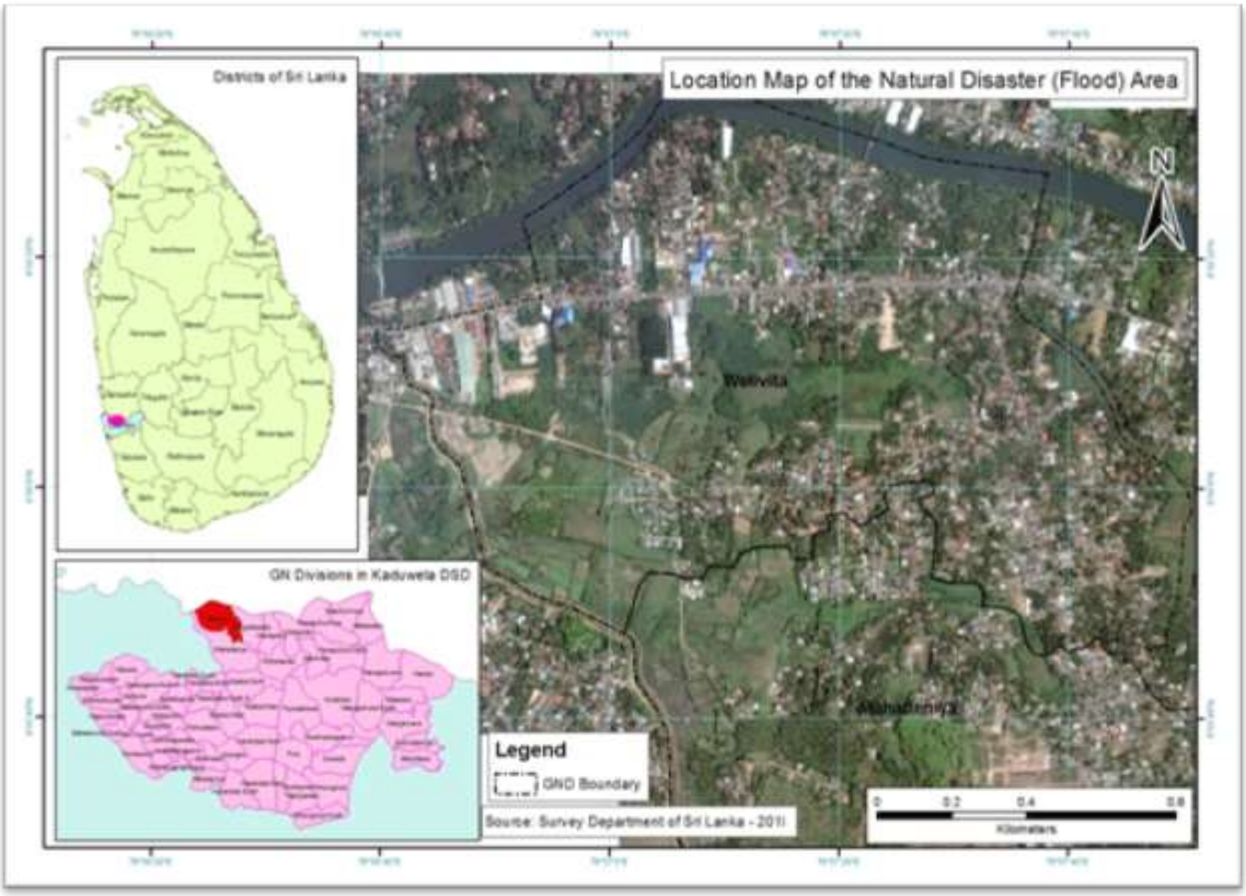

Figure 02: Study Area

METHODOLOGY

As discussed above, spatial data is most import to integrate with non-spatial tabular data. Used methodology is shown in Figure 03.

1:10,000 scaled spatial data layers including road network, building, land use, admin boundaries, contours, heights and Places of Interests (POIs) used as secondary data of Survey Department of Sri Lanka (SDSL). It was important to update the road network, land use and building data layers using recent satellite imageries in 2015. Recent Google maps used to update above spatial data for taking accurate results. GND boundaries data was joined with department of Census and Statistics 2011 non spatial data to make detailed attribute table of GND boundary layer. This helped to map the study area accurately. All the buildings of the study area needed to be updated and integrated with the election database and Samurdhi recipient databases with the support of Grama Niladhari officers and leaders of community development organizations in the study area. As these officers know well about the people of each building of the study area, it was very useful to update the building database including number of floors, building usage, ownership etc to do different spatial analysis.

Rapid field data survey was done using a hand held Global Positioning System (GPS) device to identify the maximum flood level in selected locations. GPS height values and 1:10,000 data of SDSL were used to build the 3D Digital Elevation Model (DEM) for generating 0.5m interval contour lines. Overlaying collected sample GPS survey points on the 0.5m interval contour lines, it was easy to demarcate the affected area. This was used to identify the affected buildings and the road network. Overlaying identified affected boundary layer on updated building data layer, it was easy to identify the affected building types with the support of Grama Niladhari Officers and leaders of community development organizations.

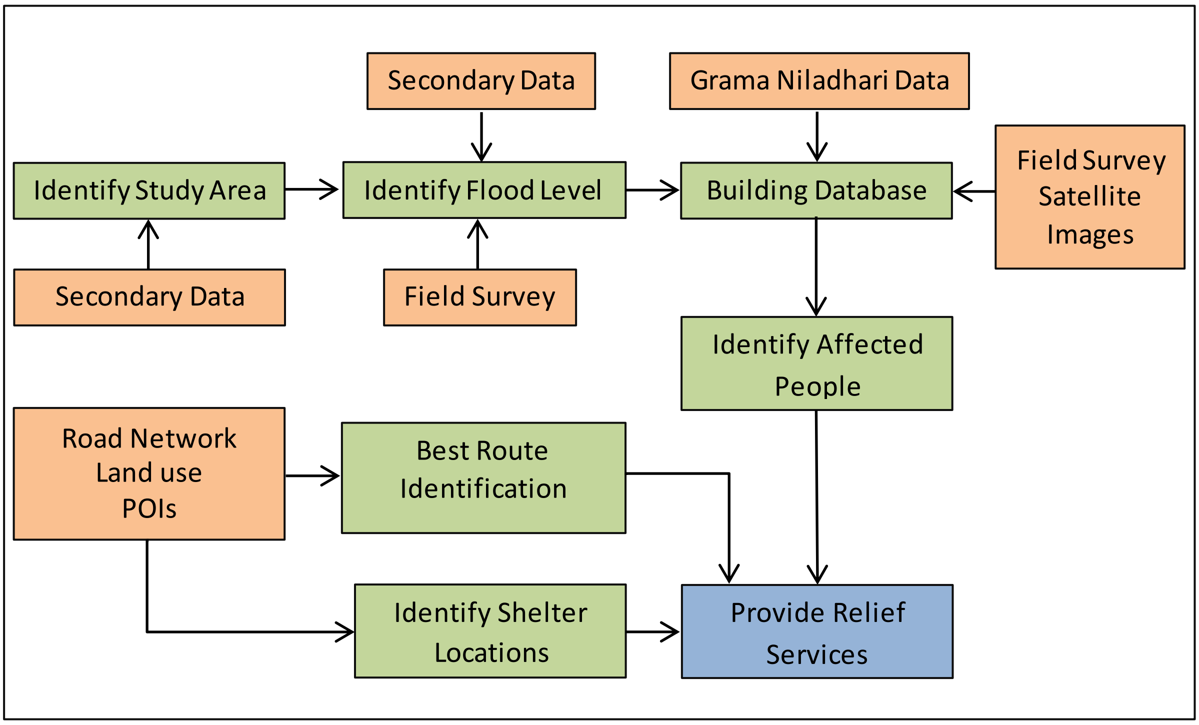

Figure 03: Used methodology for identifying affected areas and to provide relief service

Affected roads were identified overlaying flood affected boundary layer on the road network. This was used to find best routes to reach refugee camps / shelters to provided facilities by vehicles. Land use layer were used to find routes for boat services to provide facilities by water where refugee camps /shelters are located in islands made by floods, because existing roads cannot use to reach these single islands.

RESULTS AND DISCUSSION

Identification of affected area using developed 0.5m DEM is not sufficient accurate, because used 1:10,000 base contour lines were 5m interval lines. Total extent of 2.21sqkm area was identified as flood affected in Welivita and Mahadeniya GN Divisions. 977 houses were affected with people As well as 138 commercial buildings, 38 industries and 16 public and semi-public buildings were identified as flood affected buildings. Based on the election data provided by the Grama Niladhari officers, it was easy to identify number of elders who were living in affected houses. Figure 04 shows the affected areas and buildings of the study area. Also this map shows the main distribution centre, refugee camps /shelter locations, food and other necessary items distributed locations in each area.

The main refugee camp was the Welivita St. Mary's School located next to Catholic Church. Most of the affected families were there and coordinated by the Grama Niladhari of the Welivia Division. In addition to that, Welivita Buddhist temple and Rubberwatta shelter used as temporary refugee camps. Services provided using available roads and boat services continuously until the disaster ends. Most of them came and distributed goods among people without identifying them. So, affected and not affected people got lot of benefits due to unplanned distribution. So, collect goods did not go to correct point and some people were not happy about the distribution mechanism.

Road network was influenced by the flood and affected length of the Class A roads was the 1,678m. And 391m length of Class C roads and 9,835m length of Class D roads were identified as affected. Non-affected roads use to find best routes to distribute goods such as dry rations, clothes, school items, cleaning items, medicine etc. for refugee camps. ArcGIS 10.4 software and Network Analyst extension used to create a network data set for identifying best routes to required refugee camps / shelters and other distribution locations. Land use in the flooded area used to find best routes for boat services to save victims lives and provide above facilities to refugees. Sri Lanka Navy and few other volunteer groups were using boats to provide above services.

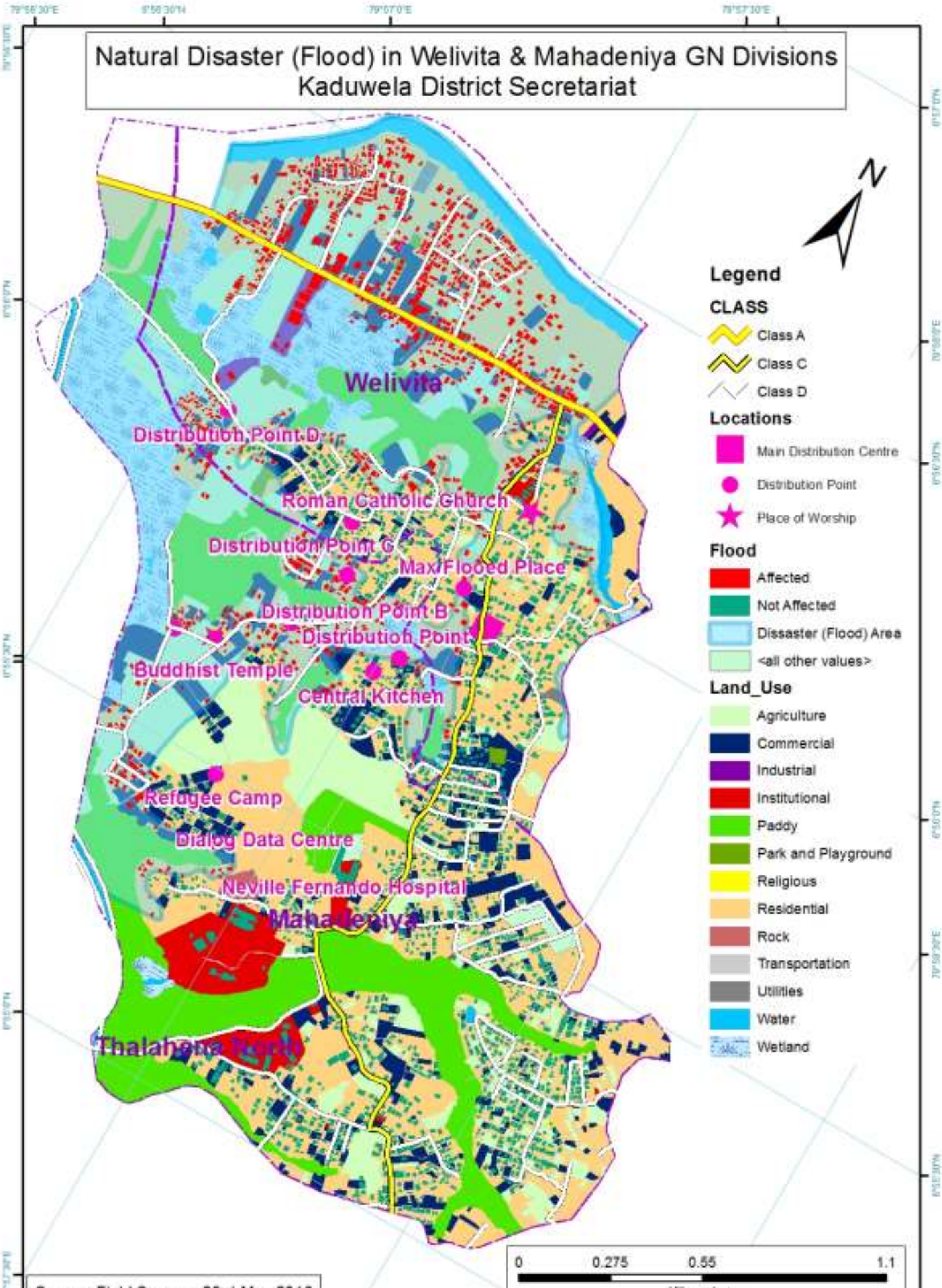

Figure 04: Affected areas, buildings of the study area

All the provided services went only to affected people who had a real requirement to manage their day today family needs. These all the services were recorded on hard copies and later entered to GIS database to analyzed spatially. This information was used to provide a transparent service for the affected people very efficiently and effectively. Figure 05 shows distribution of goods among identified affected people.

Figure 05: Distribution of goods among identified affected people

Spatial analysis techniques used to identify the affected building density in the disaster area. It shows mostly damage areas and least areas for providing post disaster services. Spatial distribution of affected buildings shows in Figure 06. This helped to identify the mostly affected zones and least zones for future analysis.

Due to this disaster, most of the properties were lost by refugees. Some of them had only the house without any property/items at home. They saved only their lives, and need to start their lives again collecting all the valued properties. As a united nation, it is important to support people who are affected by disasters to come back to their previous level for succession lives.

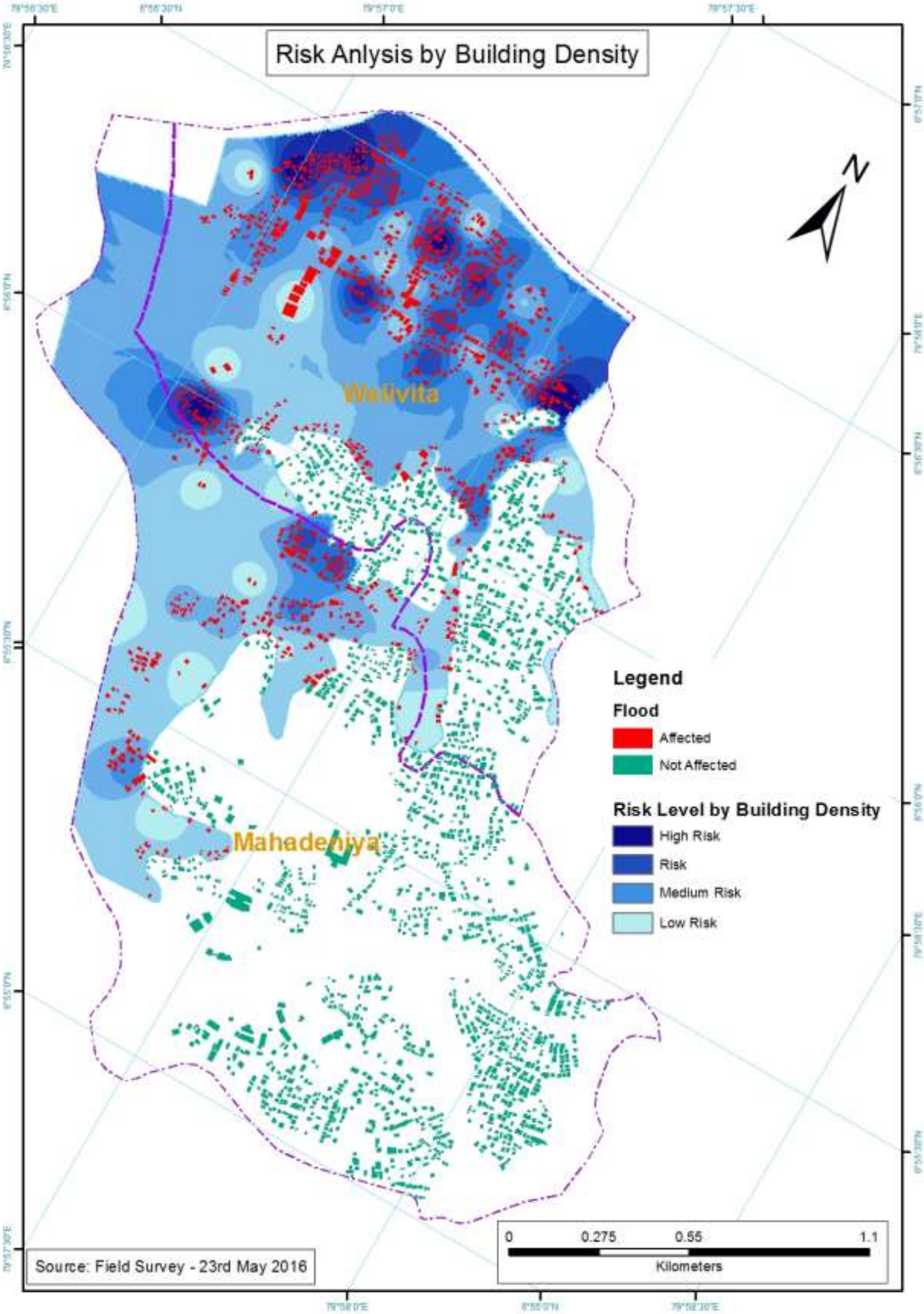

Figure 06: Spatial distribution of affected buildings

CONCLUSION

Identification of affected people scientifically and provide required services to them transparently is difficult. GIS technology can be applied to build geographic relationships to answer most of the spatial problems. Identification of disaster proven areas to resettlement and up to the final level is location based. So, this research methodology can be applied to identify affected people and provide services effectively and efficiently throughout the disaster. So, this gap can be filled using GIS technology, and can be improved up to web based or mobile base technology to access using internet from anywhere, anytime using any devices any one. Spatial technology is important to move to smart city concepts while bring digital world to the hand.

Building information system is useful to do different types of analysis and to identify legality, usage, poverty, population etc. Also, can be applied for future urban planning, create regulations and parameters to legalize buildings and disaster mitigation by the relevant authorities. In addition to that, overlaying disaster data layer on the land use or building layer, it is easy to find best lands for developments and to recalculate land values of affected and non-affected areas. This spatial database is more useful for Grama Niladhari officers' day to day operations, and the district secretariat divisions to develop important spatial database integrating existing databases to share with other organizations for providing better services while getting business benefits.

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