Towards a Sustainable Volunteered Community: An Analysis of the OpenStreetMap Community in Japan and Its Activity After the 2011 Tohoku Earthquake

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***Abstract*--Artifacts and community activities of the OpenStreetMap (OSM) have been used for a variety of social activities. In recent years, in Japan, the Ministry of Economy, Trade and Industry has promoted open government as evidenced by its open government data strategy. It is expected that improving the quality of the OpenStreetMap will be one of its open data projects. There is a unique feature of the OpenStreetMap of early Japan in the background of the challenges. The two unique feature of the OpenStreetMap of early Japan are summarized below: (1) Import of large-scale data, such as digital national land information data has been by small contributors. (2) At the time of crisis mapping of the 2011 Tohoku Earthquake, the basic data of the OpenStreetMap had not been maintenance enough. The purpose of this study is to veri_ed unique feature by data analysis. The two _ndings of this study are summarized below: (1) In Japan, the number of artifacts is very large with respect to the number of contributors. (3) An unusual number or artifacts were created by contributors immediately after the 2011 Tohoku Earthquake.**

I. INTRODUCTION

The OpenStreetMap(OSM)[1] is a volunteered geographic information (VGI) [2] project. The OpenStreetMap artifacts and OpenStreetMap community activities are a process of generating information through the use of a variety of social activities that can contribute to society in disaster prevention, education, welfare, industry, tourism, and regional revitalization.

Attention must be paid to the information quality of OpenStreetMap artifacts. Contributor activity in the process of generating information in an OpenStreetMap community clarifies the influence it has on information quality. Community activity can be analyzed as one example of VGI. Furthermore, result of analysis aims at generalizing the acquired knowledge as an example of collective intelligence. Findings of our study are also important feedback to the VGI and the OpenStreetMap community. In recent years, Japan's Ministry of Economy, Trade and Industry has promoted open government, as evidenced by its open government data strategy. Improving the quality of OSM is expected to be one of its open data projects. The OpenStreetMap activity analysis is important to the promotion of open government.

There is a unique feature of the OpenStreetMap of early Japan in the background of the challenges. The purpose of this study is to verified by data analysis. The verified by data analysis is as follows:

(1) Import of large-scale data, such as digital national land information data has been by small contributors. It is possible to consider the ratio of the number of artifacts (data) and the number of contributors has become unbalanced. To be verified by comparing the data analysis of other regions of Japan and non-Japan.
(2) At the time of crisis mapping of the 2011 Tohoku Earthquake, the basic data of the OpenStreetMap had not been maintenance enough. It had to start from the input of the basic data such as roads and buildings. Basic data had not been maintenance also Haiti earthquake. The basic data of the OpenStreetMap had not been maintenance at the time of the Haiti earthquake similer to the 2011 tohoku earthquake. I verify compared to the Haiti earthquake.

The three findings of our study are summarized below:

(1) Japan has a very large number of artifacts with respect to the number of contributors. This may create uncertainty for future of sustainable community activities.
(2) During the contributor activity immediately following the earthquake, more than the usual number of artifacts were generated. In addition, the disaster situation concerning collapsed buildings and land damage increased the amount of data.

The structure of this paper is as follows: We explain Background and Purpose in the section 2. We define the OpenStreetMap data quality in the section 3. The section 4 explains our research resources and defines the index data. The section 5 analyzes the details of our survey. We conclude our paper with section 6 which describes our survey results and future issues.

II. BACKGROUND AND PURPOSE

A. The OpenStreetMap

Since 2004, OpenStreetMap has been creating worldwide geographic databases that can be edited by anyone [10]. The OpenStreetMap makes creative and productive maps. In addition, the OpenStreetMap has a method for addressing when a map cannot be used due to legal and/or technical issues.

The OpenStreetMap currently boasts about 1,600,000 registered users around the world (Jan. 2014). The OpenStreetMap contributors are called "Mappers." They create and update geographical information data worldwide. Geographic databases are created by crowdsourcing and mappers can edit simultaneously, as in Wikipedia. API services can be used for geographic information databases with a digital the OpenStreetMap map by anyone under the Open Data Commons Open Database License (ODbL) [14], which is available worldwide. [27] [28] [26] [29] [24] [6].

The artifacts of OpenStreetMap are utilized in various areas of society. OpenStreetMap community activities are socially valuable because they are expected to impact regional activity and town revitalization.

B. Japan of the OpenStreetMap

In Japan, The OpenStreetMap Activities was started by grassroots volunteer contributors from 2008. The early OpenStreetMap in Japan was less contributors. Contributors have created a basic data by the data input of a large amount of digital national land information data. Contributors at the time thought that they must spread OpenStreetMap in Japan. As one of the means, The OpenStreetMap Foundation Japan (OSMFJ) [13] was established in Dec. 2010 for spread and sustainable activities of the OpenStreetMap in Japan. However, it is not necessarily the problem is solved by the establishment of OSMFJ. It is necessary to spread in order to sustainable activities.

Situation of the early the OpenStreetMap in Japan are summarized below.

(1) The OpenStreetMap of Japan was input of large amounts of data by small contributors. The early OpenStreetMap in Japan was less contributors. Contributors have created a basic data by the data input of a large amount of digital national land information data.

(2) To sustain long-term incentive and motivation of contributors in voluntary projects it is difficult. OpenStreetMap is a voluntary activity, there is no binding force, such as a company. Activities of contributors strongly depends on the motivation and incentives of individual contributors. There is no guarantee that current contributors to perform sustainable activities.

Challenge of the early the OpenStreetMap in Japan are summarized below.

(1) They need to sustainable activities by increasing the contributors of the OpenStretMap. The OpenStreetMap of Japan was input of large amounts of data by small contributors. The OpenStreetMap is kept features by sustainable activities. Small contributors in Japan is difficult to maintain the OpenStreetMap data. Sustainability of motivation and incentive of contributors can not guarantee everyone. To sustainable activities by increasing the contributors of the OpenStretMap.

(2) They need to spread as a sustainable activity to all parts of the OpenStreetMap. Early contributor of Japan entered a lot of data in Japan as a whole. The OpenStreetMap data should be maintained in the latest situation. It is carried out by local contributors is ideal. Contributors that made the input is difficult to maintaining a wide range of data. They need to spread as a sustainable activity to all parts of the OpenStreetMap.

C. Crisis Mapping of the 2011 Tohoku Earthquake

At the time of the 2011Tohoku Earthquake, the crisis mapping was carried out by the OpenStreetMap contributors around the world. The Crisis mapping is a task of data of the geographical situation of damage in the affected areas.

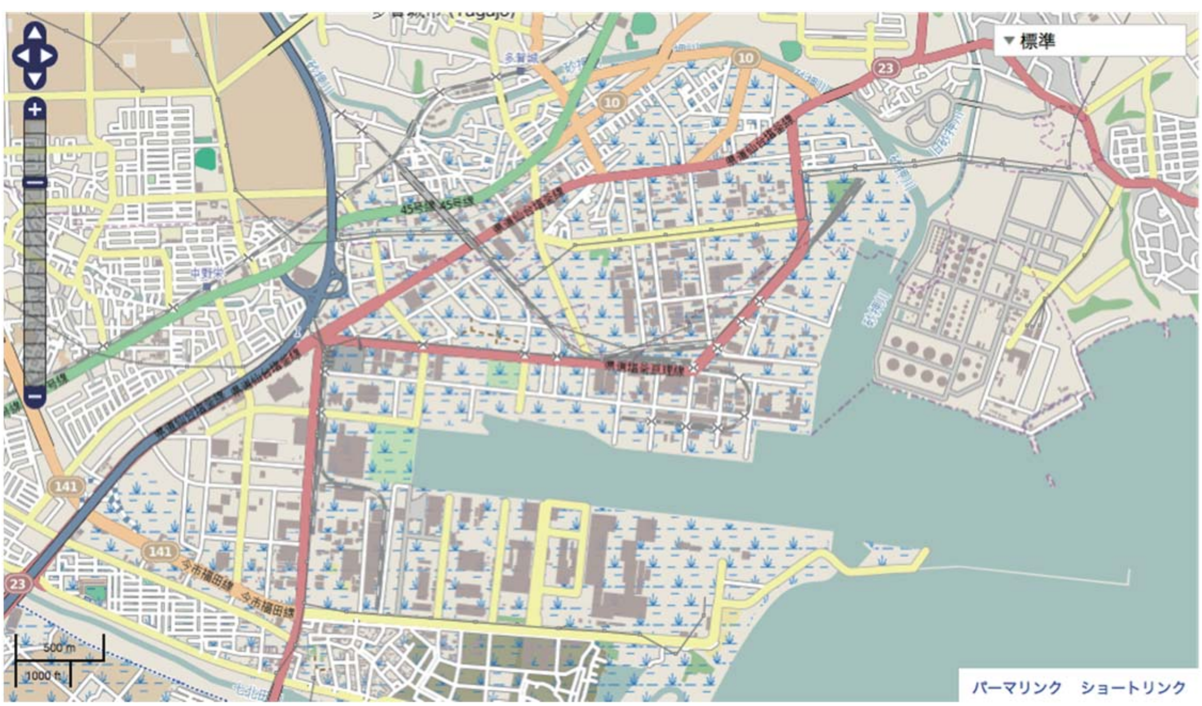

Fig. 1. OpenStreetMap: After the 2011 Tohoku Earthquake near Sendai-city

Situation of activities after the 2011 Tohoku Earthquake in Japan are summarized below.

(1) Basic data of the OpenStreetMap has not been maintained sufficiently. Affected areas was more extensive. Data of work by the crisis mapping has been difficult.
(2) Contributors were input of large amounts of data by the Yahoo road data. Large amounts of the Yahoo road data is input in order to compensate for the basic data of the OpenStreetMap.

Challenge of Japan is needed in the future are summarized below.

(1) Improvement of basic data of the OpenStreetMap is required for disaster possible future. It is necessary to enrich the OpenStreetMap data in normal times. When crisis mapping is performed in the event of a disaster, it is possible to be data of a disaster situation with minimal effort. It becomes possible to help to rescue site that require prompt action.
(2) It is necessary to increase the contributors as well as spread throughout the OpenStreetMap. Crisis mapping of the OpenStreetMap can support the relief efforts in disaster. Crisis mapping can be carried out efficiently by maintained basic data of the OpenStreetMap in disaster area. The OpenStreetMap of Japan is not widespread enough. Region that can not be developed in a sustainable basic data of the OpenStreetMap in many cases. It is necessary to increase the contributors as well as spread throughout the OpenStreetMap.
(3) Commitment to open data of local government is required. Crisis mapping was very difficult for obtaining shelter information has been difficult. Data format and licenses of shelter information were all different. The need for open data became clear. Commitment to open data of local government is required.

D. Purpose

There is a unique feature of the OpenStreetMap of early Japan in the background of the challenges. The purpose of this study is to verified by data analysis. The verified by data analysis is as follows:

(1) Analysis 1 : Comparison with Japan and other regions

Import of large-scale data, such as digital national land information data has been by small contributors. It is possible to consider the ratio of the number of artifacts (data) and the number of contributors has become unbalanced. To be verified by comparing the data analysis of other regions of Japan and non-Japan.

Compared with other regions, Japan's the OpenStreetMap has a very large number of artifacts with respect to the number of contributors and a small number of tag artifacts. Volunteers of the Japanese the OpenStreetMap community began importing Digital National Land Information data [3] in 2008 and the importation of Yahoo! Japan/Alps road data (Yahoo data) [4] began in April of 2011. Importing large amounts of data during periods of low contributor activity is not found in other OpenStreetMap regions. It is expected that, when comparing Japan with other the OpenStreetMap regions, this extremely large number of artifacts with respect to the number of contributors with fewer artifact tag numbers will be a characteristic not found in other the OpenStreetMap regions. If this is the case, while work has been done actively through this small group of contributors, this creates uncertainty for the future of sustainable community activities.

(2) Analysis 2 : Trends in data before and after the 2011 Tohoku earthquake

At the time of crisis mapping of the 2011 Tohoku Earthquake, the basic data of the OpenStreetMap had not been maintenance enough. It had to start from the input of the basic data such as roads and buildings. Basic data had not been maintenance also Haiti earthquake. The basic data of the OpenStreetMap had not been maintenance at the time of the Haiti earthquake similer to the 2011 tohoku earthquake. I verify compared to the Haiti earthquake.

The number of contributors and the number of artifacts in Japan's the OpenStreetMap increased rapidly immediately after the 2011 Tohoku Earthquake with the import of a large amount of Crisis Mapping data regarding affected areas by contributors around the world [9]. In addition, Yahoo! data began being imported in April of the same year [16] [15]. Predicted by the activities of contributors after the earthquake, the number of artifacts and the number of contributors increased rapidly. By analyzing the artifacts before and after this earthquake in Japan, as a whole, changes in contributor activities and information products could be clarified. In addition, we also investigated the nature of these artifacts.

For purposes of the above, I investigate quantitatively analyzed by the data analysis.

III. QUALITY OF THE OPENSTREETMAP

A. Specification of the OpenStreetMap

The quality of OpenStreetMap is defined by the OpenStreetMap artifacts and ChangeSet. The OpenStreetMap artifacts are composed of objects and tags, and ChangeSet is the management of the entire edit history. The OpenStreetMap objects have three types of elements: nodes, ways, and relations (Figure 2).

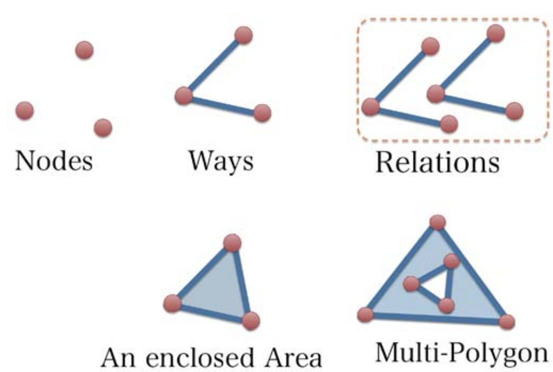

Fig. 2. Example of objects

Nodes are points. A node is used as a structural unit of the way along node registration and location information. Ways are lines. A way is used as the center line of tracks, roads, rivers, etc. An area is represented by an enclosed place.

Areas are used for buildings and river basins, etc. Relations are a grouping of nodes and ways. A relation is used to represent multiple elements together, such as buildings, transport routes, and more. It is also used to represent an area of complex shapes with holes (Multi-polygon). Object has only latitude and longitude information users add tags in order to have more overlap information for an object.

A tag is represented in a key-value format. Tagging a flexible object adds a variety of information in addition to position information. Using Wikipedia as an analogy, objects correspond to pages and tags correspond to content.

B. Quality of the OpenStreetMap

An object has only latitude and longitude information used to represent shape and position information. It has the aspect of a ”geospatial information database.” Users add tags in order to give an object more overlap information. Attaching a tag to an object with location information adds a variety of information. This has the aspect of a ”general-purpose information database.” (Table1)

Existing map data does not contain these two aspects. They are unique features of OpenStreetMap and are important factors when discussing the quality of OpenStreetMap information.

The quality of the object is an element of the ”number of data” and ”accuracy” concerning retention in the geospatial information database aspect. An object has ”positional accuracy,” ”connection accuracy,” etc. ”Positional accuracy” is the positional accuracy of the object and ”connection accuracy” is the accuracy of the presence or absence of overlap and connection of ways. The number of data is the number of objects. We define the quality of a tag as an element of the ”number of data” and ”accuracy” concerning retention in the general-purpose information database aspect. Accuracy is the accuracy of the value of the tag and the number of data is the number of tags.

IV. DATA AND QUALITY MEASURE

A. Data

For analyzing Japanese data, we extracted Japanese the OpenStreetMap data from the OpenStreetMap planet data (planet.osm) for the period from November 7, 2007 to April 30, 2012. Japanese community activity began in 2008 and the extracted Japanese OpenStreetMap data is sufficient for our analysis. The extracted Japanese the OpenStreetMap data is stored in the PostgreSQL database (extended with PostGIS) by osm2pgsql. The database usage capacity is about 500 GB. We used the data of 77 regions from the ”OpenStreetMap ODbL acceptance by region” website (http://odbl.de/) on April 30, 2012. We compared these data with Japan and other regions.

B. Quality measure

OSM Merit

This paper used OSM merit to measure the quality of these elements as defined on the odbl.de website. OSM merit is calculated by the following formula (1):

$$\text{OSM merit} = N + (5 * W) + (20 * R) \quad \ldots\ldots\ldots\ldots (1)$$

N: The number of nodes , W: The number of ways , R: The number of relations

”OSM merit density” is the OSM merit per unit area. ”OSM merit per capita contributor” is the average OSM merit of the contributors.

Node-way ratio

According to OpenStreetMap specifications, if several different pieces of information are added to one way (for example, information regarding bridges, tunnels, one-ways, the number of road lanes, etc.), the way must be split according to this different information. The number of nodes does not change, but there is an increase in the number of ways. In other words, increasing the number of tags decreases the nodes per way.

In this paper, a measure of the number of tags and the number of artifacts (the number of objects) is used as an indicator of ”simple” in the number of tags, the ratio of the number of nodes and the number of ways (node-way ratio). The node-way ratio is calculated by the following formula (2):

$$\text{Node -Way Ratio} = N/W \quad \ldots\ldots\ldots. (2)$$

N: The number of nodes , W: The number of ways

Regions with a small number of objects (OSM merit) develop dissemination. They tend to have relatively large amount of long ways and tend to increase the node-way ratio. Editing a large number of contributors may affect the node-way ratio and the variability of node-way ratios in the region will increase.

TABLE 1. QUALITY OF THE OPENSTREETMAP

	Objects (Aspect of geospatial information database)	Tags (Aspect of general-purpose information database)
Accuracy	Accuracy of objects (Positional accuracy, connection accuracy, and more)	Accuracy of tags
The number of data	Number of objects	Number of tags

On the other hand, regions with a large number of objects (OSM merit) tend to have relatively short ways and tend to decrease the node-way ratio. Editing a large number of contributors does not affect the node-way ratio and the node-way ratio converges to a constant value.

V. RESEARCH AND ANALYSIS

A. Analysis 1 : Comparison with Japan and other regions

Comparison of object density

We investigated 77 regions, including Japan (April 30, 2012), and before the 2011 Tohoku Earthquake (March 9, 2011) in terms of object density (OSM Merit Density). Table 2 shows the top 15 regions and Japan just before this earthquake. OSM merit density was used to compare the number of objects in different regions of the area. However, Monaco has many narrow urban areas and thus will have an extremely large value compared with other regions. Monaco is an exception to this paper.

TABLE 2. OBJECT DENSITY (OSM MERIT DENSITY) (2012.4.30)

Region	Area(km2)	OSM merit density
Monaco	2	(1)11,289,000
Netherlands	41,543	1,990,387
France	551,500	646,358
Czech Republic	78,867	540,552
Luxembourg	2,586	527,690
Belgium	30,528	490,872
Germany	357,111	490,827
Gaza	360	441,267
Slovakia	49,035	437,450
Switzerland	41,277	421,356
Austria	83,871	361,974
Denmark	43,094	306,936
Japan (2)	377,835	(5) 280,999
Europe (3)	4,324,782	258,064
Great Britain	243,610	253,014
Japan (2011.3.9)	377,835	(4) 124,472

The upper region of Table 2 shows the popular regions of the OpenStreetMap. These are the OpenStreetMap advanced regions. Japan is 13th (Table 2(2)), yet is higher than the average in Europe (Table 2(3)) and is approaching the level of the OpenStreetMap advanced regions. The number of objects in Japan more than doubled from about one year before the earthquake (Table 2(4)) until April 30, 2012 (Table 2(5)).

Comparison of the number of objects per contributor

We investigated 77 regions, including Japan (April 30, 2012), before the 2011 Tohoku Earthquake on March 9, 2011 in terms of the number of objects per contributor (OSM Merit per contributor). Table 3 shows the top 15 regions and Japan just before earthquake.

The number of objects per contributor in Japan is very large (Table 3(1))– more than 16 times the average in Europe (Table 3(2)).

TABLE 3. THE NUMBER OF OBJECTS PER CONTRIBUTOR (APRIL 30, 2012)

Region	The number of objects	OSM merit per contributor
Monaco	90	339
Netherlands	5,069	3,300
France	13,409	4,684
Czech Republic	3,590	2,842
Luxembourg	639	786
Belgium	3,537	2,947
Germany	47,207	1,732
Gaza	111	13,355
Slovakia	1,336	4,094
Switzerland	4,776	1,596
Austria	4,386	1,873
Denmark	2,332	2,365
Japan (2)	1,965	(1) 64,814
Europe (3)	124,907	(2) 4,003
Great Britain	13,400	4,653
Japan (2011.3.9)	854	149,133

Conclusion of analysis 1

The number of objects for Japan is approaching that of the OpenStreetMap advanced regions and has doubled since about one year after the earthquake. We found the following three main factors:

(1) In Japan, the OpenStreetMap dissemination has been actively conducted. (2) At the time of the 2011 Tohoku Earthquake, Crisis Mapping was performed by volunteers from around the world. (3) Yahoo! data began being imported in April of 2011.

Japan has a large number of artifacts per contributor, which is a feature unique to the Japanese community. Much editing has been conducted by only a few contributors, who have been actively working. On the other hand, a small number of contributors to VGI creates an unstable situation. In other words, a slight change in the motivation of existing contributors can have a great influence on data maintenance and the updating of the OpenStreetMap data in the future. In order to develop a sustainable community in Japan, the number of contributors must be increased.

B. Analysis 2 : Trends in data before and after the 2011 TohokuEarthquake

The number of contributors before and after the earthquake

The number of contributors in Japan was 854 people before the Tohoku Earthquake (March 2, 2011) with an increase to 1,179 after the earthquake (March 30, 2011). This is an increase of about 400 people (about 1.5 times), with new contributors increasing due to Crisis Mapping (Table 4).

Figure 3 shows the number of contributors (blue line) and the number of objects (OSM Merit) per contributor (red line) before and after the earthquake. Immediately after the earthquake, the number of contributors increased dramatically. The number of objects per contributor decreased temporarily because the number of contributors increased so rapidly.

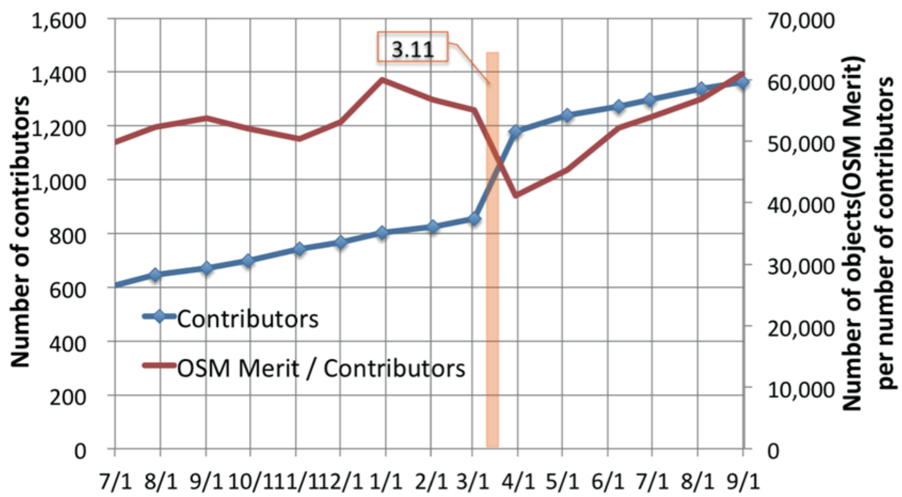

Fig. 3. The number of contributors and the number of objects per contributor

TABLE 4. THE NUMBER OF CONTRIBUTORS BEFORE AND AFTER THE EARTHQUAKE

Date	Number of contributors
2011.3.2	854
2011.3.30	1179

Increasing the number of ways

The work of importing Yahoo! data began on April 1, 2011, after the earthquake. We examined the ratio of the number of objects. Table 5 shows increases in the number of ways weekly, the amount of Yahoo! data weekly, and the number of road data of none Yahoo! data weekly, and the percentage of Yahoo! way data.

The increase in the number of ways weekly averaged about 6,000 before the earthquake. By mid-March, after the earthquake, it increased about seven-fold to about 40,000 (Table 5(1)). After the start of the Yahoo! data import process on April 1, 2011, the number of Yahoo! data weekly increased quickly (Table5(2)). The percentage of Yahoo! way data grew immediately after the start of work to 90% (Table 5(3)) and, at the end of May, was 98% (Table 5(4)).

The number of road data of none Yahoo! data weekly from April until the end of May decreased (Table 5(5)(6)). After April 1, the focus of editing work switched to the importation of Yahoo! data.

The increase in the number of roads weekly before the earthquake averaged at about 2,000 km and was about 12,000 km (about six times greater) after the earthquake. The increase in roads weekly has grown rapidly from April when the Yahoo! data import process began. We confirmed that editing was actively carried out.

TABLE 5. THE NUMBER OF WAYS AND THE INCREASE IN THE NUMBER OF YAHOO! DATA WEEKLY

date	Increase in the number of ways weekly	Increase in the number of Yahoo! Data weekly	Increase in the number of road data of none Yahoo! data weekly (6)	Percentage of Yahoo! Way data
2/3-2/9	1,113	0	1,113	0%
2/10-2/16	8,397	0	8,397	0%
2/17-2/23	9,444	0	9,444	0%
2/24-3/2	6,297	0	6,297	0%
3/3-3/9	4,770	0	4,770	0%
3/10-3/16	(1) 43,122	0	43,122	0%
3/24-3/30	38,926	2,398	37,727	6.16%
4/1-4/6	92,046	(2) 77,941	14,105	84.68%
4/7-4/13	104,022	95,188	8,834	(3) 91.51%
4/14-4/20	82,573	75,480	7,093	91.41%
4/21-4/27	153,162	144,984	8,178	94.66%
4/28-5/4	141,057	134,606	6,451	95.43%
5/5-5/11	39,485	33,960	5,525	86.01%
5/12-5/18	192,774	188,716	4,058	97.89%
5/19-5/25	199,962	196,541	(5) 3,421	(4) 98.29%

Editing status of source tag

Figure 5 shows the total artifacts around the earthquake, extracted from Bing satellite data (Bing Maps) (blue line) and Yahoo! data (red line) from the source tag. Crisis Mapping of the data based on a variety of satellite photos that was provided by every institution would be too cumbersome. Therefore, in this paper, we analyze using only Bing Maps. Bing Maps had 83,413 artifacts before the earthquake, which increased rapidly from April after the Yahoo! data import process began. After April 1, with the beginning of the Yahoo! data process, it increased about two-fold to 165,911. Yahoo! data increased more rapidly than in April. In other words, Crisis Mapping using Bing Maps was active immediately after the earthquake and the focus of editing work switched to the import of the Yahoo! data border on April 1, which confirms the findings of the previous section.

Editing status of land use

We used the ”landuse tag” for the use of land in the OpenStreetMap and analyzed the increases in the number of landuse tags. Specifically, they are landuse tags (residential, industrial, commercial and farming of values), building tags, and riverbank tags.

Table 6 shows the increase in the average number of landuse tags weekly for before and after the earthquake. All tags in the investigation increased for each area in the weeks after the earthquake. Residential tags grew more than 3,700 times. It was also necessary to introduce the regional data of areas submerged by the tsunami. The number of farm tags and riverbank tags also increased significantly due to deformation of the terrain by the earthquake.

There were approximately 4,000 million (m2) building tags before the earthquake. In June, building tags doubled to 8,000 million (m2). The number of residential tags stopped at 13,000 million (m2) of editing until just before the earthquake, but, by mid-April, residential tags reached approximately 20,000 million (m2). Subsequent editing has not been carried out. Building tags and residential tags were edited intensively immediately after the earthquake.

Conclusion of analysis 2

After the earthquake, Crisis Mapping increased with approximately 400 new contributors and Crisis Mapping using Bing Maps was actively carried out. The focus of editing moved to the Yahoo! data work border on April 1. Many artifacts were created. Many contributors became victims of the status data of collapsed buildings and land. Detailed satellite photos from Bing Maps were a major source of data.

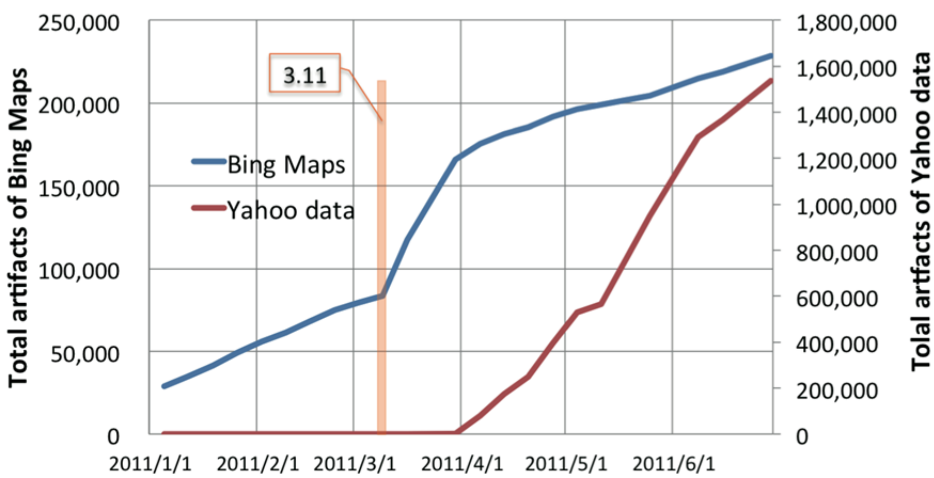

Fig. 5. Total artifacts of Bing Maps and total artifacts of Yahoo! Data

TABLE 6. INCREASES IN THE NUMBER OF LANDUSE TAGS BEFORE AND AFTER THE EARTHQUAKE

Landuse	Before the earthquake 1/12-3/9 (m2)	After the earthquake 3/10-3/16 (m2)	Rate of increase (times)
Building	1,994,105	9,881,312	4.95
Residential	5,332	20,070,314	3763.90
Industrial	5,838,185	8,829,698	1.51
Commercial	81,243	305,389	3.75
Farm	18,176	846,823	46.59
Riverbank	1,174,303	24,850,135	21.16

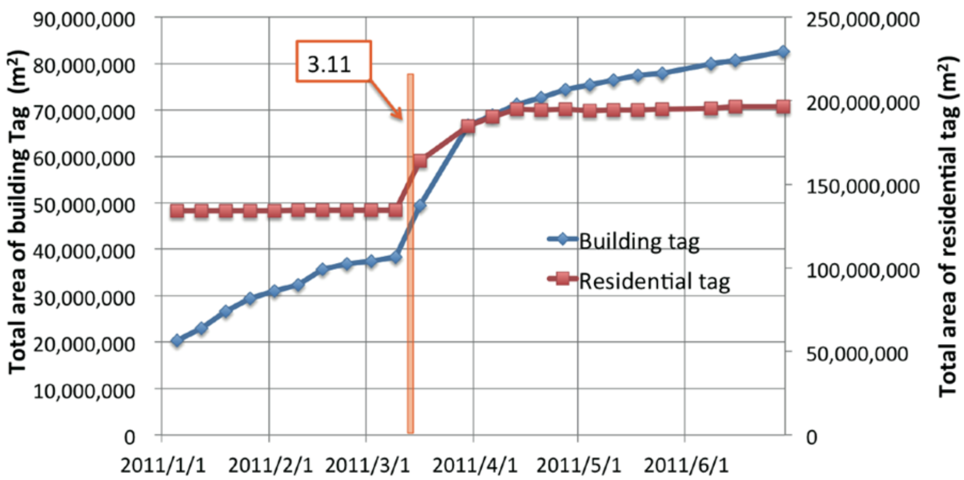

Fig. 6. Total area of building tags and total area of residential tags

VI. CONCLUSION AND FUTURE WORKS

A. Conclusion

The findings obtained as a result of our analysis are set forth below:

Analysis 1: Comparison with Japan and other regions

The number of artifacts in Japan is approaching that following the Tohoku Earthquake. However, the ratio of the number of contributors to the number of artifacts was more than 16 times that of the European average. This indicates that the OpenStreetMap community in Japan has been very active. It is a community that depends on the motivation of contributors in which there is an element of sustainable activities anxiety.

Analysis 2: Trends in data before and after the 2011 Tohoku Earthquake

After the earthquake, the number of artifacts and contributors grew rapidly as a result of Crisis Mapping and the importing of Yahoo! data. Crisis Mapping using Bing Maps was actively carried out after the earthquake. The editing process shifted its focus to the Yahoo! data work border on April 1. Crisis Mapping by many as a result of the disaster situation of collapsed buildings and land was verified. Detailed satellite photos from Bing Maps played a major role and was found to be an important information source.

The OpenStreetMap in Japan began as a grassroots movement in 2008. Many artifacts were produced by the activity of only a few contributors. Our paper demonstrates the need for a sustainable the OpenStreetMap community in Japan and, therefore, there is a need to increase the number of contributors. The number of contributors and artifacts increased after the earthquake. We expect to improve the quality and dissemination of the OpenStreetMap in the future. Continued observation will be necessary.

B. Future works

The future study will be stated now. Research in Japanese the OpenStreetMap has not determined an upper limit to the number of artifacts. We will conduct a similar analysis of other regions and the entire OpenStreetMap. At the same time, we will analyze changes in the area and distance of artifacts, as well as analyze the growth and productivity of the community. In this paper, we analyzed overall changes to Japan after the earthquake. Further detailed research is needed that focuses on the Tohoku region and investigates contributor incentives for participation in Crisis Mapping.

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