Multi-functional utilization of suburban green space: text mining to analyze “Forest around the Mountains” Satoyama activities

Q Y Xiang1*, Y M Mao1, and K Furuya1

1 Graduate School of Horticulture, Chiba University, 648 Matsudo, Matsudo-shi Chiba 271-8510 Japan
E-mail: yumulisha@gmail.com

Abstract. Due to the acceleration of urbanization, many green spaces are facing the fate of abandonment, especially the urban and suburban green space. In Japan, these suburban green spaces can also be used as a Satoyama. Satoyama is a multi-purpose ecosystem, including some secondary forests, farmlands, lakes, marshes, and so on. They are affected by human beings and benefited each other. It is proof of harmonious coexistence that human beings have been groping for in nature since ancient times. This study collected the records of the Satoyama activity group in Matsudo City, Chiba Prefecture, Japan from 2008 to 2019, and used KHCode3 to mine the characters. The purpose of this study was to identify that it is found that people use suburban green space in variety nowadays through the activities of volunteers in Satoyama. From the records, the green space has a series of changing stages after becoming Satoyama, in which 2008-2011 is the first stage, and 2016-2019 is the other stage, but 2012, 2014, and 2015 were grouped separately. In addition to the daily maintenance of the forest, there were also some special words that can be seen that people attach great importance to the publicity of Satoyama as a place for Children's environmental education. For the future, Satoyama activities can afford good references to urban green space multi-function, maintain ecological balance, and keeping sustainable development.

Keywords: multi-function, suburban, text mining, Satoyama, volunteer

1. Introduction
In this time of global urban densification, urbanization is developing more and more rapidly, and the concentration of labor force forms densification [1]. More and more abandoned green lands appear in farmland, mountainous and suburban areas [2]. However, many studies show that human beings who have been dependent on nature need green space since ancient times [4][5] both physically and psychologically due to the existence of biological affinity [3]. The famous theories are stress recovery theory (SRT) and attention recovery theory ART [6], shown that the experience in nature can bring a good effect on relieving stress and restoring attention. There is a contradiction between the human demand for green space and the ignoring of green space. It is an important part of the current project to make effective and reasonable use of green space in the city. In particular, the small suburban green space, which is close to the city and easy to be ignored, will be used because it is mistaken for private territory [7]. In Japan, small suburban green space can be used as sustainable development and utilization of resources as Satoyama [8].

“Satoyama” has the significance of agricultural land opposite the remote mountains,
which can be used in agricultural production as fuel, compost, grass ash, and other supplies [9]. In the past, it was the existence of heat sources. However, with the development of urbanization, secondary forests were not fully utilized due to many miscellaneous forests are replaced by new energy [10]. Now people not only pass on the traditional functions of the forest to the next generation, but also can reuse Satoyama with new ways in order to build a sustainable development environment and make Satoyama proper management.

The main significance of Satoyama activities includes: (1) the sustainable management and utilization of resources; (2) the living and cultural development of symbiosis with nature; (3) [12] the sustainable use of space protecting the biodiversity of the secondary forest. [13][14]. In addition, environmental education, forest bathing, natural observation, and forest operation can be the parts of Satoyama-[15].

But most of these studies are paying attention to typical activities of Satoyama Mountain in one region or often far away from the city. Satoyama activities in the urban-suburban green space will be a better choice for the urban residents [16]. In some studies, it is common that researchers participate in Satoyama activities for a short period of time before reporting [13], but we cannot know how the volunteer group establishes Satoyama in a short period of time. On the other hand, for Satoyama activities, researchers will focus on it from the perspective of normal citizens [17]. That is not common to do a long-term follow-up from the perspective of volunteers.

Therefore, the purpose of this study is to find out what the specific activities in the multi-functional place like Satoyama and to know the how a volunteer group change and develop a suburban-urban green space of Satoyama through text mining of “Forest around the Mountains” reports. we want to show the diversified and the supplementary utilization of the suburban green space as Satoyama in this study from the special perspective of volunteers. We can also understand how the area is developed as a place to hold Satoyama activity through text mining. Finally, the diversity of activities in Satoyama in Japan described in this study can be used as a reference for other countries, and the detailed time course can help us have a deeper understanding of the development of suburban green space.

2. Methodology

2.1. Study Area

2.1.1. History of the Forest
This forest is named as “囲い山の森” in Japanese and has the same meaning as “Forest around the Mountains” in English, which is located in the area between Goko and Kanegasaku, Matsudo City, Chiba Prefecture. The total area is about 200 meters from north to south, 100 meters from east to west, about 2 hectares. In 1782 of Edo period, the squire of Kawagoe Domain began to immigrate here and develop. Until about 1960, the forest has been used as a place to obtain building materials, logs for firewood and charcoal, fallen leaves for composting, and dead branches for fuel. However, since the use of oil, plastics, and chemical fertilizers, the forest has largely lost its traditional use. A lot of small shrubs such as Aucuba japonica and broad-leaf bamboo became more and more without management for a long time. Because sunlight was seldom coming in, the trees also grew denser than before. (Figure 1)
2.1.2. History of the Group of the Forest around the Mountains

Volunteers come from the second “Introduction of Satoyama Volunteer Lecture”, which was held by the Matsudo city government, which was focusing on graduates to set up new Satoyama activity groups. At that time, the new group was named “the group of the forest around the mountains”. It has been looking for sample plots and carrying out activities since the spring of 2005. And it began to record the activities on October 10, 2007. Since then, they were starting the activity here on the first Saturday and the third Tuesday of every month. At first, the forest was dark that could not be illuminated by sunlight so many bamboos in front of the forest could not be seen at all. During this period, volunteers devoted themselves to open the activity venues centering on making the forest bright. In order to protect biodiversity here, less than half of the human activity area was built, and the rest was the living places of many animals and plants like orioles, Chinese bamboo partridge, Japanese Woodpecker, Japanese tit, and so on. (Figure 2)
2.2. Methods and tools
The research procedure is divided into three steps: sorting out, analyzing, and interpreting. First of all, for “sorting out”, go to the official website of the Forest around the Mountains. In the activity record, each year was divided into four parts by 3 months, like January to March will be a part. And one part contains 8 to 13 records. Each record contains activity time, date, weather, participants, nature observation, Satoyama activity, and next plan. Secondly, about analyzing, we need to extract the Satoyama activities and classify them by year. Thirdly, KH coder 3 [18] was used for text mining, and two types of maps of “co-occurrence” and “correspondence” were obtained. Finally, using the keyword in context (KWIC) concordance to select keyword searches to interpret the meaning of keywords in the figure.

3. Results and Discussion

3.1 High frequency of words for descriptive analysis
In the description of Satoyama activities, volunteers’ work was extracted as the main body
of analysis. Overall, KH coder3 was used to perform preprocessing, and 625 paragraphs and 1,777 sentences were confirmed after simple statistics. In addition, the total number of extracted words (the total count of all words contained in the object file) was 38,499, and the number of distinguished words that can be used was 16,148. In addition, auxiliary words, auxiliary verbs, and other general words in the article were excluded. As the words used in the analysis, 4,441 words were extracted (3,775 different words). (Table 1)

Table 1 Basic information after KHcoder3 analysis

| Database stats   | Tokens (in use) | Documents Units | Sentences |
|------------------|-----------------|-----------------|-----------|
| Types (in use)   | 4,441           |                 | 1,777     |
|                  | (3775)          |                 |           |

Among them, the current frequency of the first 100 frequent words was shown in Table 2. Among the 100 frequently used words, the verb “Cut (172)” appeared most frequently. There were 20 words related to nature, and the most frequently used word was “Forest” 141 times. Most of the words for plants are “Forest (141)”, “Tree (114)”, “Branch (74)” and other general nouns. Among them, there are also words such as “Cedar (37)” which specifically indicated plant names. There was a noun for a natural disaster like “Hurricane (28)”. What’s more, there was a word for quantifiers like “Hon, a kind of Japanese quantifiers about trees (46)”, words for action “Fall down” and adjectives like “High (32)” and “Withered (17)”.

Secondly, there were 22 verbs that closely related to human activities, such as “Cut (172)”, “Logging (138)”, “Work (75)”, etc.; there were 20 words indicated place, such as “Square (140)”, “Passage (66)”, There are 16 nouns of behavior, such as “Observation (57)”, “Events (50)”, “Treatment (49)”; and 5 nouns related to time like “Day (29)”, there were 5 words associated with Children, such as “Swing (30)” and “Hammock (22)”. There were 10 nouns in another category: the representative was “Rope (70)” as a tool; the “Music (17)” derived from the activity; the word “Danger (18)” indicated that the safety was important in the activity; “Litter (37)” had the most frequent occurrence in this category.

In addition to reflecting the biodiversity of the Satoyama environment, volunteers also need to maintain the environment after the disaster. Logging and pruning took up most of the time, for example, the word “Rope” was accompanied by logging because high trees need to be pulled down with ropes after using a saw. This can be seen in the description of the “Fall down” of trees. In addition, “Observation” of “Nature” was also very important for Children to play. This can be seen in the emergence of “Swing”, “Hammock” and other simple game facilities. The most obvious thing that we need to know about a lot of nouns and verbs had a high frequency of people's actions. But we need to look at the contents shown in the figure of co-occurrences to understand the relationship between words and dig deeper into the meaning of Satoyama activities.

Table 2 Documents frequency of the top 100 words

| Words    | DF (h5) | Words | DF (h5) | Words | DF (h5) |
|----------|---------|-------|---------|-------|---------|
| Cut      | 172     | West  | 35      | Nature | 25      |
| Forest   | 141     | Preparation | 34 | Before | 25 |
| Square   | 140     | Weeding | 34 | Surroundings | 24 |
| Logging  | 138     | Fall down | 34 | Playground equipment | 24 |
| Tree     | 114     | Confirmation | 33 | Schedule | 24 |
| Work     | 75      | Activities | 33 | Meeting | 23 |
|          |         |        |         | Cornus controversa | 19 |
|          |         |        |         | Information | 19 |
|          |         |        |         | Enclosure | 19 |
|          |         |        |         | Child | 19 |
|          |         |        |         | Cleaning | 19 |
The centrality for co-occurrences of words and analysis of Satoyama activities

The “co-occurrence network” was used when we were analyzing the data. To ensure the words appeared meaningful, the minimum number of words appearing in “term frequency” was set as 20, and no upper limit. Document frequency did not set the upper and lower limits. Only noun, SA variant noun (In Japanese grammars these words are classified as サ変 sa-hen, an abbreviation of サ行変格活用 sa-gyō henkaku katsuyō, sa-row irregular conjugation), adjective, verb, adjective, noun B, and noun C need to be checked in the selection column. The word “Top 60” was selected in “Filter edges”, and its frequency was divided into 50, 100, 150, and 200, four levels. After these steps, we described a network diagram (Figure 3, Figure 4) connecting words with similar patterns (i.e., words with a strong co-occurrence degree). In the co-occurrence network diagram, the stronger the co-relationship was, the thicker the lines were. And the words with higher frequency would be described with larger circles. In the following, the words in the co-occurrence network will be explained with the original excerpt of the Satoyama volunteers’ reports by using KWIC concordance to confirm how the words are used from the original text (keywords would be into bold). (Figure 3)

According to the number of connecting black lines, the vocabulary can be divided into three categories. First, there were 7 groups with weak connectivity that can express little meanings, because of the words connected with 2 or fewer black lines. Secondly, the groups connected with three to five black lines were medium connectivity groups. There were two groups in the research. Finally, only one group’s words with five or more black lines connected in figure 3. At last, we chose meaningful groups with a strong middle connection to be explained.
Figure 3 The central co-occurrence of reports in the Forest around the Mountains

In the group with strong connectivity, we can see that “Tree” is the center. Judging from the size of the circle, it was also the word with the most frequent occurrence, extending to the left and right sides. To the left, “Rope”, “Swing” as the bridge, and were connected with the words like “Set up”, “Climb”, “Net”, “Hammock”, “Child”, “Picture-story show”, “Enclose”, “Playground equipment”. We searched “Child” as the keyword, you can see the sentences containing these words: “playing on the cable car in the central square: Swing, hammock, vertical net, climbing net on the tree, etc. adults and Children enjoy it very much.”; “The picture-story show is very good! I was deeply impressed, by the way the Children played freely and happily.” When extending to the right, it used “Branch”, “Logging” and “Direction” as a bridge to connect with other words used in Satoyama to show preparation, for example, the words used to describe tree felling are: “Fall down”, “Tow”, “Cut”, etc. When we input “Direction” in KWIC concordance, we can get some sentences like: “Together with the treatment of shrubs, we should investigate the falling of the tree by towing. The priority of operation is keeping safe.” Combined with figure 4, we know that the meanings of these actions were about transforming Satoyama into a playground that can provide environmental education for Children. Volunteers tried their best to develop facilities in limited venues, including climbing, artificial making, picture-story show, etc. The establishment of multi-functions was related to the daily management of the Forest around Mountains.
Two groups with medium connectivity expressed their meanings clearly: One is "Collection", "Litter" and "Classify". With "Litter" as the keyword search, the sentence you can get is “The final collection and classification of the litter: in the whole activity area, we usually pay attention to litter collection.” “Today, we will focus on classification and treatment, and we have been fighting with litter almost all day. The statistics of litter collection are shown on a separate sheet.” Another was “Weeding” for the “Square” as the main body of the “Event”, and a simple description of the square was given. The orientation of the squares was at the “South” side, “Entrance” or the “Passage”. “Square” was regarded as the keywords to search, the relevant sentences were “along the north side of the road, Entrance Square, South side Square of the implementation of weeding.” “Mowing the North / South Square.” “The work of making passage in the grassland of Southwest.” These can become a multi-functional place, cannot exist without the maintenance of volunteers. Nearby residents or passers-by will throw litters in. On the other hand, Satoyama is a part of nature where many weeds grow. That will bring weed cover and make Satoyama more invisible (there is no garbage can on the roadside in Japan, someone throw garbage into the weeds to cover it.) As a public place managed by people, if there is no volunteer maintenance and management, this situation will continue in a vicious circle, and the forest will gradually become a dump.

3.3 Correspondence analysis of words every year of Satoyama activities
In the KH coder, the “Correspondence analysis” instruction was used. To ensure that words
appeared meaningful, the minimum frequency of words in term frequency was set to 20, and no upper limit. Document frequency does not set the upper and lower limits. Only noun, SA variant noun, adjective, verb, adjective, noun B, and noun C were checked in the selection column. For the correspondence analysis option, we chose the option with words and variables to classify words by date. The size of the circle is related to the frequency. When we followed the steps, the bubble plot with labels was expressed in figure 5. It can be seen that the green space was becoming a series of changes from the initial to the later stage after being Satoyama, in which the period from 2008 to 2013 was one part, and the period from 2016 to 2019 was the other part. Because the words of 2012, 2014, and 2015 were relatively special, which were separated into groups respectively.

The words from 2008 to 2011 were “Square”, “Fallen leaves (deciduous)”, “Log”, “Cut”, “Quercus myrsinifolia”, “Broad-leaf bamboo”, “High”, “Event”, “Withered”, “Bag”, “South”. These words were used as keywords to search for sentences, for example, “Because there is no leaf of deciduous trees, the crown is cedar, the middle layer is Quercus, at the bottom, you can see Aoki who started to grow again.”; “In the afternoon, a log (Mukunoki), which can be the pillar of the signboard.”; “Get acquainted while listening to the sounds of insects in the southern grassland (Event Square).”; “Quantity bags of garbage: bottles/17 bags, 5 cans, 5 bags, 40 plastics, 3 combustible rubbishes, 3 umbrellas, 15 large junk.” These sentences clearly expressed the preparation stage of the initial work, including: “cutting down trees”, “weeding”, “arranging activity square”, “clearing garbage”, etc. (Figure 5)

In contrast to the other group, the words presented from 2016 to 2019 were “Maintenance”, “Cleaning”, “Work”, “Nature”, “Harvest” and so on. We can see the sentences with these words like “Maintenance around and inspection of the stage and seats for the 'Music Concert' in the forest.”; “Cleaning dead trees scattered by typhoons” “After that, in the spring sunshine, while observing the nature and carefully observing the newly opened working channels in the Southwest area, we enjoyed the luxuriant natural scenery of 'Forest around the Mountains'.”; “Taro potato harvest, garbage disposal.”

![Figure 5](image)

**Figure 5** Correspondence analysis of Satoyama activity by year without words and frequency
The words of 2012 were related to “Dead branches”, “Warehouse” and “Rope” that these are still in the preparation stage and conform to the main components between 2008 and 2013. In 2014, “Child” and other words indicated the environmental education and children’s games carried out in the middle of the activity preparation. “Picture-story show” was also for children. But it was very special for Satoyama’s routine activities, far away from the whole, which can be explained as Satoyama activities are not only related to nature but also the culture between human beings’ heritage culture. “Westside”, “road”, “Cornus controversa”, etc. appeared in 2015 like a transition phase. There were the new venues and roads as preparations to connect with activities between 2016 and 2019, including fields for harvesting food, observation of nature, concerts, and so on.

4. Conclusion
Firstly, among the most frequent 100 words, KH coder3 found that the words related to people’s activities occupied the main part, indicating that the maintenance of Satoyama required a lot of labor. These activities included the construction and felling of trees in response to disasters, and the restrained development of forests to preserve natural diversity. Secondly, we learned from co-occurrence that volunteers created various facilities for children in limited venues. In order to complete these facilities, they also invested a lot of preparation labor and time. Also, their works included the treatment of garbage, maintaining a good ecological environment, turning the forest into a beautiful environment that can be used by people. Finally, according to the year classification of correspondence analysis, the overall development process of the “forest around the mountains” activity group is obtained: open up Satoyama activity site (2008-2013) - excessive children’s playground (2014) - development of Satoyama (2015) - formation of diversified Satoyama activities (2016-2019).

This study is to describe the activities of Satoyama from the volunteers’ perspective and find out the significance that they give to Satoyama activities. For the sustainable development and utilization of suburban green space, their activities have a great reference. For children’s education, urban residents can consider carrying out environmental education in Satoyama, teaching with entertainment. And there are more places to look forward to using Satoyama diversified.

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