The rise big data for maintenance roadside greenery (Study the damage tree database in Surakarta, Central Java)

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Abstract. This research question is ‘how to build the database of trees roadside in Surakarta?’ The research objectives are: (1) Identification of the trees characteristics (type and size); (2) Identification level of the healthy trees, and (3) Trees location. This research used categorized methods by healthy of tree, that is: healthy, little damage, moderate damage and heavy damage. The research location at Jalan Slamet Riyadi, Jalan Jenderal Sudirman and Jalan Urip Sumohardjo at Surakarta City. There are several resuts can be drawn: (1) This research has build a Tree Inventory Application, named SIPPOHON. Through SIPPOHON trees can be inventoryed by the name, type and characteristics. Tree location is integrated in a global positioning system (GPS); (2) The Polyalthia longifolia, Mangifera kemanga, Diospyros blancoi have a strong endurance tree; (3) Pterocarpus indicus, Erythrina, Manilkara kauki, langerstroemia and Casuarina tend to be damaged or unhealthy; (4) Some forms of tree damage are caused by: hollow and hollow trunks; mechanical damage (scratches and cuts that hurt the tree to the cortex); pest attacks that cause the stems to become brittle; swelling of the stem; the partial canopy is dead; trees tilted into the electricity grid; and roots come to the surface. The result of the research are applicaton to manage the green roadside, expecially: (1) Treatment of pest are needed to prevent the spread of disease; (2) Routine maintenance and monitor the tree condition.

1. Introduction
As one of the attributes of the green city, green urban spaces are very important [1]. Vegetation as the main component of green open space have a great contribution in controlling environmental quality [2]. The presence of tree as green roadside is enricht the pleasant environment for road users, absorb the pollution and produce oxygen. In addition, trees have physical properties to provide aesthetic values of shape, texture, color, smell and other parts. Trees need a long time to produce all of that. [3]. To optimize these functions and benefits for formed the physical, ecological, social, and architectural comfort, the tree as green roadside need to be maintained continuously [4]. The governemt should be set the good policies for manage the roadside trees, especially in logging activities. To logging the tree must have a good reason. Cutting downnor logging the trees only be done if very forced [5]. Although all parties agree on the benefits of the trees, in the fact bargaining position of ‘maintaining’ the trees set at the bottom priority. Policy and development paradigms often promote the economic and social parameters and leave...
environmental sustainability. The argue if benefits of trees are difficult to measure, even visually less visible physically as a cause of ignoring the tree strategic value as explained above. Trees grow unhealthy, have no aesthetic appearance, spread pests and diseases, tilt, and often falling over urban infrastructure, individual property (cars or houses) and even on people, causing casualties. In response to the safety first principle, some good trees are often cut down for reasons of anticipation or mitigation of typhoons. This situation also happened in Surakarta city, Central Java. The Environment Office declare if it difficult to answer the request for tree felling on the roadside in a short time due to the absence of accurate data. Field checks are required to conduct research. In other hand, special conditions of tree such as unhealthy trees due to disease and pests are found in the field. This conditions make logging requests seem urgent. Based on this dilemma, the Environment Office Surakarta rised big database to describe the accurate tree conditions. Through this step, the logging (eradication) and maintenance of roadside trees can be carried out properly and right on target. So, the formulation of this research question is ‘how to build the database of trees roadside in Surakarta?’ The reasearch objectives are: (1) Identification of the trees characteristics (type and size); (2) Identification level of the healthy trees, and (3) Trees location. The expected of this activity is to produce a database of trees that is integrated through the development of spatial-based information systems. The development of this information system can be used to strengthen the database of trees in the Surakarta city as well as to monitor and prevent logging without rational consideration. Tree location marking is done using a global positioning system (GPS).

2. Methods
The study was conducted in 2017. The survey location based on the green roadside listed in Surakarta Mayor Regulation number 24 at year 2011 concerning Urban Forests and Green Roadside. Some of these roads are Jalan Slamet Riyadi, Jalan Jenderal Sudirman and Jalan Urip Sumohardjo at Surakarta City.

To identify the number and concession of trees in each location, data and information were collected through direct observation and identify the geographical location of tree points using GPS. Observation of the physical condition of the tree is done visually for the whole tree at the bottom of the roots (which are on the surface of the ground), stems, leaves, and branches. The physical condition assessment is based on 2 criteria, namely health and technical conditions in the form of slope of the trunk that has the potential to threaten the house, road, electricity network and mechanical damage. Observation of the physical condition of the tree is done descriptively based on visual conditions in the field. Physical observations of the tree include: (1) Tree names and types, (2) Trunk circles, (3) Tree height, (4) Canopy width, (5) Spacing between trees and (6) Tree Location coordinates. Tree location data is obtained through scanning the location of each tree using GPS GLONNAS type to see the location of coordinates in the form of UTM X and UTM Y as well as geographical coordinates. Recording data is processed using MapInfo Professional 11.0 / ArcGIS so that it can be mapped on a digital earth map.

Where as the assessment of tree health level is based on the following indications. Tree categorized as healthy or normal when the trees still carry out its physiological functions. Conversely, the trees are unhealthy if the trees are structurally damaged either in whole or in part. This condition is caused by the disease, pathogenic living organisms or physical environmental factors [6]. The abiotic factors cause the tree damage are physical and chemical factors that make up the environment where the growth does not support the normal growth or development of forest trees, including temperature, humidity, climate, nutrients, water pollution, lack of oxygen and light [7].

According to Mangold (1997) in [8] the trees damage occurred by the many factor, such as:

a. Cancer. Symptoms of cancer showing by damage the form of swelling of the stem that extends to the top and bottom. The woody tissue on the swollen trunk generally becomes soft,
brittle, cracked, and is often used for insect protection. Cancer may be caused by various agents but more often caused by fungus. In areas where the topography is sloping (bumpy) and a lot of wind, trees suffering from cancer of the trunk are easily broken and fallen [9].

b. Heart rot, fruit body and weathered further. Symptoms of these showing by the form of decay at the base of the stem, then accompanied by the presence of leaves in the canopy that turn yellow and dry. This condition caused by the death of tissue cells in plants. Death of plant tissue is usually preceded by a change in colour from green to yellow then to brown or reddish due to attack by pathogens. This damage is difficult to observe from the outside, but the emergence of the fruiting body is an advanced indicator of weathering caused by fungi.

c. Open wound is a wound or series of wounds that are shown by peeling off the skin. In this case the inside of the wood has opened and the next further weathering. Usually open wounds are caused by pruning wounds that cut into wood.

d. Resinosis and Gummosis. Resinosis is a discharge in the form of resin from the diseased part of the plant, and is called gummosis if it is gum. Occurs only if the trunk or branch is injured or injured until it hits the xylem and has a pathogen. This type of damage will make the tree sick because it loses a lot of sap and invites disease attacks.

e. Dieback is type of damage where the death of a branch or branch from the end and extends to the cambium. Dieback is not necessarily the result of one factor such as the result of destructive organisms or a prolonged dry season, but because of the accumulation of a lack of nutrients that triggers the damaging organisms.

f. Broken or dead roots causes the illness.

g. Loss of dominant tip or the death of shoots. The death of shoots are usually caused by weather, insects and diseases. The dead of shoots causes the growth of the trees not straight, shoot tissue becomes dry, brittle and rotten. The quality of growth are decreases. The death of shoots in generally causes by the damage to plant tissue or xylem blockage.

h. The damage of bud, leaf or shoots are the leaves eaten by insects or fungi attacked

i. Changes in leaf colour started from brownish yellow leaf spot, reddish brown to dark brown. If there are several spots in one leaf, patches can coalesce to form a large patch area. These patches can develop quickly to form a blight.

Based on the above indicator, a scoring tabulation was made to categorize the condition of the tree, that are healthy, little damaged, moderately damaged and heavily damaged levels. See the table 1. The typical damage of the trees are shown in Figure 1, and the physical condition of the trees are shown in Figure 2.
3. Results and Discussion

3.1. Tree Information System (SIPPOHON)

After survey, the data is comprehensively tabulated to produce a score of the condition of the tree whether it is healthy, little damaged, moderate damage and heavily damaged or fallen prone. The table also includes photos to visualize the physical data of the tree. In this form also informed the condition of the stand, roots, trunks, canopy and urban infrastructure around the tree (such as roads, gutters, buildings and so on). See the Table 2.

After counting, there are 2,753 trees (2,198 trees on Jl. Slamet Riyadi, 151 trees on Jl. Jendral Sudirman and 404 trees on Jl. Urip Sumoharjo). The amount of information identified makes this data large enough and requires adequate management to function as an optimal data reference [5]. The Surakarta City Environmental Office made a Tree Inventory Application, named SIPPOHON (see Figure 3). Through SIPPOHON, inventory of trees can be seen from their name, type and characteristics. Tree location is integrated in a global positioning system followed up with the provision of tree card identification. With the existence of SIPPOHON, maintenance, care and felling of trees on the green roadside can be managed well and right on target.

3.2. Tree Condition

After categorizing used the scoring methods, information is obtained as described below. On Jalan Slamet Riyadi, there are 2,198 trees consisting of 57 species of trees, spread on the north side of 931 trees and on the south side of 1,267 trees. The most species of trees are Glodokan (Polyalthia longifolia) 230 trees (10.46%), then Angsana trees (Pterocarpus indicus) 188 trees (8.55%), Apple Bludru (Diospyros blancoi A. DC.) 146 trees (6.64%), and Asem Keranji (Dialium indum) 126 trees (5.73%). See the Table 3.

Of the 2,198 trees, most had healthy conditions (1,259 trees = 57.28%) and were little damaged (705 trees = 32.07%). All young trees (less than 10 cm in diameter) are in good health. Trees that have moderate and heavy damage are 234 trees (10.64%), most of them are Asem Keranji (Dialium indum) and Angsana (Pterocarpus Indicus). Indications of damage has showing by: (1) hollow stem; (2) there is a pest attack on the stem and brittle; (3) There is swelling in the stem and some die; and (4) technically a portion of the sloping stem.

Not much different, the condition of the green roadside in Jalan Jendral Sudirman mostly have good condition (healthy and little damaged). In the Jendral Sudirman road, there are 151 trees with 20 species, spread on the west side 71 trees and on the east side 80 trees, (2) Most tree species are Glodokan pecut (Polyalthia longifolia) 41 trees (27.15%), Angsana (Pterocarpus Indicus) 17 trees (11.26%), Tabebuya (Tabebuia rosea) 15 trees (9.93%).

The trees on Jendral Sudirman are mostly in good condition (healthy). Trees are prone to falling as many as 6 trees (3.97%) with the category of fallen prone (heavy damage) and moderate
Table 1: Scoring method for tree health and technical conditions

| Variable                  | Tree Health Parameters                                                                 | Score | Weight |
|---------------------------|----------------------------------------------------------------------------------------|-------|--------|
| The healthy of steem      | Heavily Damaged                                                                      | 2     | 30%    |
|                           | Moderately Damaged                                                                  | 3     | 30%    |
|                           | Little Damaged                                                                       | 4     |        |
|                           | Healthy                                                                              | 5     |        |
| Thehealthy of header      | Heavily Damaged                                                                       | 2     | 30%    |
|                           | Moderately Damaged                                                                  | 3     |        |
|                           | Little Damaged                                                                       | 4     |        |
|                           | Healthy                                                                              | 5     |        |

| Variable                  | Parameter Tree Technic Condition Parameters                                         | Score | Weight |
|---------------------------|--------------------------------------------------------------------------------------|-------|--------|
| The slope of the tree     | Heavily Damaged                                                                       | 2     | 20%    |
|                           | Moderately Damaged                                                                  | 3     |        |
|                           | Little Damaged                                                                       | 4     |        |
|                           | Healthy                                                                              | 5     |        |
| Mechanical damage to trees| Heavily Damaged                                                                       | 2     | 20%    |
|                           | Moderately Damaged                                                                  | 3     |        |
|                           | Little Damaged                                                                       | 4     |        |
|                           | Healthy                                                                              | 5     |        |

damage. The 6 trees consist of the Bungur (langerstroemia), Cemara (Casuarina equisetifolia), Angsana (Pterocarpus Indicus), Dadap merah (Erythrina cristagalli) Sawo Kecik (Manilkara kauki), and Glodokan pecut (Polyalthia longifolia). The fallen vulnerability is caused by (1) hollow and hole the stems, (2) pests on the stems become brittle, (3) swelling in the trunk, (4) part or all of the canopy of dead trees, and (5) non-upright stems (tilt).

On the road section of Jalan Urip Sumoharjo there are 404 trees consisting of 26 species of trees, spread on the west side 212 trees and on the east side 191 trees. The most tree species are 129 Tanjung (Minusops elengi) 31.93%, then Glodokan pecut (Polyalthia longifolia) 94 trees (23.27%), Angsana (Pterocarpus indicus) 50 trees (12.38%) and Malaba (Mangifera kemanga) 28 trees (6.93%). Of all the existing trees have quite diverse conditions. Young trees tend to be healthy, whereas some older trees have poor health and technical conditions. Trees with moderate and heavy prone conditions were 31 trees (7.6%). Trees with moderate and heavy damage consist of Tanjung (Minusops elengi), Akasia (Acacia auriculiformis), Angsana (Pterocarpus Indicus), Glodokan pecut (Polyalthia longifolia), Malaba (Mangifera kemanga) and Beringin (Ficus benjamina). Some of these trees have conditions: (1) hollow and hole stems, (2) swelling in the trunk, (3) some of the tree canopies are dead, and (4) some sloping trunks.

Referring the data compilation, it can be seen that the dominant trees planted on all of the roadsides are the type of Glodokan pecut (Polyalthia longifolia), Angsana (Pterocarpus
If we compare the tree species with the tendency of damage, we see that all tree species have relatively the same tendency to damage. Glodogan pecut (Polyalthia longifolia), the tree type as Malaba (Mangifera kemanga), Apples Bludru (Diospyros blancoi A. DC.) and Tabebuya have a healthy category or have a strong endurance. While Angsana (Pterocarpus indicus), Erythrina, Sawo Kecik (Manilkara kauki), Bungur (langerstroemia) and Casuarina tend to be damaged or unhealthy. See the Table 4.

When viewed from the shape of the canopy, all of the trees do not have special characters have broad canopy) except Polyalthia longifolia with a slim canopy. This shape making it relatively safe or strong to withstand wind loads. Based on these conditions, health factors (disease and insect attack) as well as the technical condition of the tree are factors that determine the level of tree vulnerability. This makes the management and maintenance of trees as a determines factor in quality of trees, determines when trees can be cut down or just simply care / maintenance.

In addition to paying attention to the technical aspects of trees (fallen-prone), the choice of tree species needs to pay attention to several other factors. Road sides are areas that function for the safety and comfort for road users, land for road development, buffer zones, greenery roadsides, construction sites for service facilities and protecting natural formations. The selected planting vegetation at roadsides is very important [4]. The selection of vegetation must be adjusted to be achieved with the characteristics of the vegetation. The existence of well-managed trees in urban areas can be beneficial to stabilize the conditions of the urban environment from pollution. The trees benefit in the urban environment: improving air quality [10], noise reduction [3], increasing air humidity and decreasing surrounding temperatures [11], beautifying cities [12], preservation of ground water [2] and improving traffic safety and supporting economic sustainability [13]. The benefits of greenery roadsides can be optimized if the tree has health
Table 3: Categories of Tree Condition

| No | Local and Scientific Name of the Tree | Amount (%) | The tree condition |
|----|-------------------------------------|------------|--------------------|
|    |                                     |            | Healthy Light damage | Moderate Damage | Heavy damage |
| 1  | Glodokan (Polyalthia longifolia)     | 227 10.33% | 106 89            | 31 1           |
| 2  | Angsana (Pterocarpus indicus)        | 187 8.51%  | 85 62            | 35 5           |
| 3  | Apel Bludru (Diospyros blancoi A. DC.) | 145 6.60% | 137 6            | 1 1           |
| 4  | Asem Keranji (Dialium indum)         | 125 5.69%  | 19 67            | 36 3           |
| 5  | Bintaro (Cerbera manghas)            | 121 5.51%  | 49 56            | 14 2           |
| 6  | Tanjung (Minusops elengi)            | 113 5.14%  | 68 39            | 6 0           |
| 7  | Sawo Kecik (Manilkara kauki)         | 113 5.14%  | 62 36            | 15 0           |
| 8  | Mahoni (Swietenia SP)                | 110 5.00%  | 67 36            | 6 1           |
| 9  | Bungur (langerstroemia)              | 108 4.91%  | 51 46            | 11 0           |
| 10 | Palm                                 | 96 4.37%   | 72 22            | 1 1           |
| 11 | Ketapang kencana (Terminalia mantaly) | 88 4.00%  | 68 17            | 3 0           |
| 12 | Akasia (Acacia auriculiformis)       | 82 3.73%   | 30 30            | 20 2           |
| 13 | Malaba (Mangifera kemanga)           | 81 3.69%   | 44 29            | 7 1           |
| 14 | Kambuja (Plumeria)                  | 70 3.18%   | 54 16            | 0 0           |
| 15 | Asem Jawa (Tamarindus indica)        | 69 3.14%   | 31 32            | 6 0           |
| 16 | Glodokan pecut (Polyalthia longifolia) | 66 3.00%  | 20 41            | 5 0           |
| 17 | Kiyara Payung (Filicium decipiens)   | 54 2.46%   | 29 22            | 3 0           |
| 18 | Beringin (Ficus benjamina)           | 40 1.82%   | 32 6             | 2 0           |
| 19 | Walisongo (Schefflera actinophyla)   | 39 1.77%   | 36 3             | 0 0           |
| 20 | Mangga (mangifera indica)            | 38 1.73%   | 26 11            | 1 0           |
| 21 | Ketapang (Terminalia catappa)        | 31 1.41%   | 22 8             | 1 0           |
| 22 | Tabebuya                             | 18 0.82%   | 13 3             | 2 0           |
| 23 | Perdu                                | 18 0.82%   | 16 2             | 0 0           |
| 24 | Spatodea (Spathodea campanulata)     | 18 0.82%   | 17 1             | 0 0           |
| 25 | Other trees (each species less than 1%) | 142 6.46% | 107 24           | 11 0           |
|    | Total                                | 2,198 100% | 1,259 705        | 217 17        |

Based on the study, many of trees planted are not in a healthy condition. Almost 40% of trees have damaged conditions ranging from minor, moderate and severe damage categories). These trees need adequate care so that the damage is getting worse. The healthy of trees determined by factors (1) plant selection, (2) planting methods, and (3) management of post-planting and maintenance. Plants will grow well if the selected plants are tolerant of the planting environment. The correct planting method will prepare a place that guarantees well root and canopy growth. Proper maintenance will guarantee growth at a normal pace, avoiding pest and vandalism. Conversely, if the factors that determine the growth are not right, then the plants will grow slowly, do not display the desired physical properties, and even plants will at any time
Table 4: Comparison of the dominance of tree species planted and tree species that tend to be damaged

| Information                  | Jl Slamet Riyadi                  | Jl Jendral Sudirman               | Jl Urip Sumoharjo                |
|------------------------------|-----------------------------------|-----------------------------------|---------------------------------|
| The dominant tree species are planted on each road section | - Glodokan pecut (Polyalthia longifolia) | - Glodokan pecut (Polyalthia longifolia) | - Tanjung (Mimusops elengi) |
|                              | - Angsana (Pterocarpus indicus)   | - Angsana (Pterocarpus indicus)   | - Glodokan pecut (Polyalthia longifolia) |
|                              | - Apel Bludru (Diospyros blancoi A. DC.) | - Tabebuya roses                  | - Angsana (Pterocarpus indicus)   |
|                              | - Asem Keranji (Dialium indium)   |                                   | - Akasia (Acacia auriculiformis)  |

| Condition | amount | %   | amount | %   | amount | %   |
|-----------|--------|-----|--------|-----|--------|-----|
| Healthy   | 1.259  | 57.28% | 95  | 62.91% | 265 | 65.59% |
| Light Damage | 705 | 32.07% | 50 | 33.11% | 110 | 27.23% |
| Damage    | 217 | 9.87% | 6 | 3.97% | 27 | 6.68% |
| Very damage | 17 | 0.77% | 0 | 0.00% | 2 | 0.50% |
| amount    | 2.198 | 100.00% | 151 | 100.00% | 404 | 100.00% |

| Dominant tree damaged | - Asem Keranji (Dialium indium) | - Bungur (langerstroemia) | - Tanjung (Mimusops elengi) |
|                       | - Angsana (Pterocarpus indicus) | - Casuarina               | - Angsana (Pterocarpus indicus) |
|                       |                                  | - Angsana (Pterocarpus indicus) | - Glodokan pecut (Polyalthia longifolia) |
|                       |                                  | - Dadap Merah (Eritrina cristalgalii) | - Beringin (Ficus benjamina) |
|                       |                                  | - Sawo Kecik (Manilkara kauki) | - |
|                       |                                  | - Glodokan pecut (Polyalthia longifolia) | - |

3.3. Tree Handling and Maintenance

Some alternative for tree treatments that are: (1) High or width trimming. High trimming or cutting the tree needs to makes balancing the height of the tree by supporting the roots. Normally, the root can be expanded beyond the width of the crown. This handling is not only for safety aspects (such as falling down when there are strong winds and heavy rain), cutting can also be used to obtain uniformity in tree height. Width cutting the tree canopy is based on two considerations, namely safety and health. As sam as the hight trimming, width trimming is feared that the canopy that is too wide on the tree cannot withstand from the wind and heavy rain. The falling down of the branches are endanger road users; (2) Control from Passenger Plants (parasite). A parasite or a semi-parasitic plant takes food essence from its host. To eradicate parasites, by cleaning the roots of parasitic plants; (3) Patching on Hollowed Trees. Trees that have been damaged by holes in the stem can be overcome by using a method of cavity treatment. In this method, the hole of stem covering or filling with composite mortar, sand and splits or concrete; (4) Control of Plant Pests. Pests are plant disruption in the form of organisms. Pests attack the plant tissue cause the tree damage, disease and death. Most pests are insects such as termites, caterpillars, fleas, insect borer, and others; the last is (5) tree logging as the last choice. Tree logging based on safety considerations only (the tree have heavy damage or death, so that is dangerous or vulnerable to falling).
Figure 3: The views of SIPPOHON

Through adequate handling, green urban space is also expected to be beneficial in supporting public health as reported by the World Health Organization (WHO). Some activities carried out in Green urban space can increase relaxation and recovery, increase social capital, improve immune system function, improve fitness and reduce obesity, reduce anthropogenic noise and produce natural sounds, reduce exposure to air pollution, reduce the effects of urban heat islands, increase pro-environment behavior, optimization of sun exposure thereby improving sleep quality [16].

4. Conclusion
The Surakarta City Environmental Office has made a Tree Inventory Application, named SIPPOHON. This application to manage a large number of tree data, 2,753 trees (2,198 trees on Jl. Slamet Riyadi, 151 trees on Jl. Jendral Sudirman and 404 trees on Jl. Urip Sumoharjo). The number of these trees will continue to grow over a wide area survey. Through SIPPOHON trees can be inventoried by the name, type and characteristics. Tree location is integrated in a global positioning system (GPS) which is followed up with the provision of tree card identification. With the existence of SIPPOHON, maintenance, care and felling of trees on the green roadside can be managed well and right on target.

The dominant trees planted on all of the roadsides are the type of Glodokan pecut (Polyalthia longifolia), Angsana (Pterocarpus indicus), Apple Bludru (Diospyros blancoi A. DC.), Asem Keranji (Dialium indum), Tabebuya, Tanjung (Mimusops elengi), Akasia (Acacia auriculiformis) and Malaba (Mangifera kemanga). If we compare the tree species with the tendency of damage, we see that all tree species have relatively the same tendency to damage. Glodogan pecut (Polyalthia longifolia), the tree type as Malaba (Mangifera kemanga), Apples Bludru (Diospyros blancoi A. DC.) and Tabebuya have a healthy category or have a strong endurance. While Angsana (Pterocarpus indicus), Erythrina, Sawo Keck (Manilkara kauki), Bungur
(langerstroemia) and Casuarina tend to be damaged or unhealthy. Some forms of tree damage are caused by: hollow and hollow trunks; mechanical damage (scratches and cuts that hurt the tree to the cortex); pest attacks that cause the stems to become brittle; swelling of the stem; the partial canopy is dead; trees tilted into the electricity grid; and roots come to the surface.

To improve tree management in the green roadside in the Surakarta city, it is recommended: (1) Treatment of pests that are attacked by pests with moderate to heavy damaged conditions in accordance with existing characteristics to prevent the spread of disease and damage that is getting worse; (2) Routine tree maintenance needs to be carried out such as pruning, pest control, fertilizing, watering and strengthening of sloping trees; and (3) Competent tree monitors and nurses are needed as well as involving the community to regularly monitor the condition of trees.

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