

Urban Greenery environment as Green Infrastructure

Environmental Research Field

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1. Research Background and Aims

There is a problem of expansion of Mishap risk, The declining birthrate and a growing proportion of elderly people, Delay of economic activity, Medical treatment and healthy theme, deterioration of natural ecological system at an urban area. A solution by effective land use in a city is expected from such background. Maintenance of green infrastructure is important to revival in new urban space.

It's expected to utilize the various functions a natural environment has in land use, or it's A disaster prevention(rainwater infiltration and flood alleviation, Prevention of the fire spread), Relaxation of a heat island phenomenon, environmental purification and Recreation. I'm going to do clearly by experiment investigation about the public interests function of such natural environment. It's introduced about 4 studies next to this report, or 1) Measure of heavy metal soil pollution utilized phytoremediation, 2) Study on the hot environment relaxation effect brought about by orbital greening, 3) Storm water retention and penetration in the planting bases of urban district, 4) Co-establishment of urban ecological network and urban heat mitigation

2. Research Methods and Details

1) Measure of heavy metal soil pollution utilized phytoremediation

It measured within the greenhouse in Kanagawa Prefecture. As a planting container, the polyvinyl chloride pipe (D15 cm x H200 cm) was attached. Imitation polluted soil was made. Akadama-soil which Pb could be added was filled into a container. An experiment section was set as Pb contamination level 50mg/kg, 150mg/kg and 500mg/kg, and control division (**Photo.1,2**). Test plant was made *Chenopodium album* var. *centrorubrum*, *Gossypium arboreum* and Western lawn. Seeding were put into effect in April 2016 (**Fig.1, Photo.3**). The number of leaves and stem length was measured every month as a growing investigation during the session length. Each plant and soil were sampled in November 2016. Pb was analyzed by ICP(inductively coupled plasma spectrometry).



Photo. 1 Soil where Pb was added



Photo.2 Soil is filled into a container

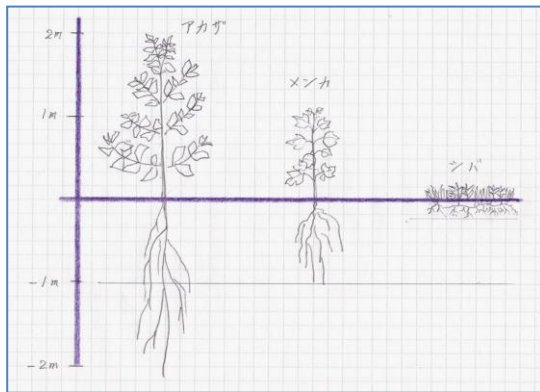


Fig.1 Section of various planting

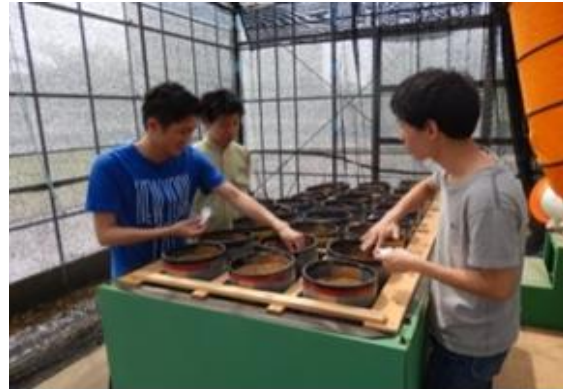


Photo.3 The situation of the seeding

2) Study on the hot environment relaxation effect brought about by orbital greenery

An experiment was conducted in the Arakawa depot Sta. neighborhood. Before experimenting planting base was established over 120 m² in the orbit. *Sedum* species is planted by vegetation base beforehand. Single planting and mixed planting were prepared. *Sedum mexicanum* was used for single planting. 4 species (*S. album*, *S. oryzifolium*, *Sedum sarmentosum*, *Phedimus aizoon*) was used for mixed planting. Measurement of the temperature was conducted in A area. A temperature sensor was arranged in surface of greenery base, H100mm and H300. A temperature sensor was also arranged in the ballast which no planted. It was every 10 minutes and the temperature was recorded by thermorecorder (Photo.4,5) . It was analyzed about temperature environment from obtained data.



Photo.4 Establishment of greenery base to an orbit



Photo.5 Arranged temperature sensor (left:Orbid greenery, right: Ballast in an orbit)

3) Storm water retention and penetration in the planting bases of urban district

3)-1 Condition of rain water retention in the planting bases of the housing complex

In Wakabadai apartment complex (**Photo.6**), located in Asahi-ku, Yokohama City, the rainwater retention characteristics in the soil of planted green areas were evaluated by the soil wetness data at the depth of 7.6cm and 20cm before/after the rainfall at the 47 sampling points in 27 greening units. The retention characteristics were analyzed by the relationship among the soil wetness changes between the different depth, the vertical distribution of the vegetation cover ratio in 10 layers at different heights, the sky ratio at the height of 2m above the ground (**Photo.7**), and the composition of the vegetation.



Photo.6 Study area (Wakabadai apartment complex) **Photo.7 Measurement of sky ratio**

3)-2 Water penetration characteristics in the planting bases of greenway in the upland urban area

In the greenway of Kouhoku New Town in Tsuzuki-ku, Yokohama City, water permeability and soil hardness were surveyed by the field test on the ground of the vegetated areas (**Photo.8**), and the relationship between the retention performance and the vegetation structure was analyzed. Water retention ability of soils in the depth of 40cm from the surface was measured by the on-site retention performance test at 14 ground points in the different vegetation types (2 points in the bamboo grass, 4 points in the Quercus forest, 4 points in the well-managed bamboo forest, 4 points in bamboo forest with no management). At the same time, vertical vegetation structure was measured by the green cover ratio in the layers at 6 different height.



Photo.8 Measurement of water permeability (left) and soil hardness (right)

4) Co-establishment of urban ecological network and urban heat mitigation

In the central urban district of Minato Mirai 21, located in the bay-side area of Yokohama City,

relationship between the habitation of butterflies and thermal environment was evaluated in the 92 segments of urban street trees and open spaces. As the ecological conditions, the distribution of the butterflies' species and individuals in each segment were surveyed by the line census, and vegetation cover ratio in the 10 layers at different height was surveyed. On the other hand, as the thermal environment, total solar radiation in the daytime of 21st June 2016, and the sky ratio in each segment were simulated by the DSM (Digital Surface Model) of the area. Using these data, important conditions for species diversity was analysed, and the segments were classified by the variables on butterfly species diversity, on vertical diversity of layers in the vegetation, and on the heat environments.

3. Research Results and Discussion

1) Measure of heavy metal soil pollution utilized phytoremediation

During the session length, growing damage of a *Chenopodium* wasn't admitted(**Photo.9**). Elution amount of imitation polluted soil was below the detection limit. But the price near the initialization was detected by the Pb content of the soil. Pb absorbed amount of the Root of *Chenopodium* is indicated on **Fig.2**. Control was below the detection limit, 11.3mg/kg of 50mg/kg section, 53.3mg/kg of 150mg/kg section and 134.3mg/kg of 500mg/kg section in plant root analytical value by short-term (63day) growing. Next control was below the detection limit, 17.3mg/kg of 50mg/kg section, 79.7mg/kg of 150mg/kg section and 262.0mg/kg of 500mg/kg section in plant root analytical value by long-term (115day) growing. When an extended period made them grow, the Pb content increased. Pb absorbed amount of the leaf and stem of *Chenopodium* is indicated on **Fig.3**. Control and 50mg/kg section was below the detection limit, 21.3mg/kg of 150mg/kg section and 54.0mg/kg of 500mg/kg section in leaf and stem of plant analytical value by short-term (63day) growing. Next control and 50mg/kg section was below the detection limit, 16.0mg/kg of 150mg/kg section and 33.7mg/kg of 500mg/kg section in leaf and stem of plant analytical value by long-term (115day) growing. The difference in the contents wasn't admitted by the difference in the period of vegetation. .



Photo.9 *Growth of Chenopodium*

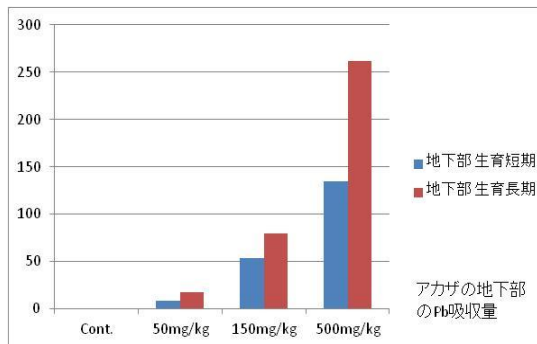


Fig.2 Pb absorbed amount of the Root

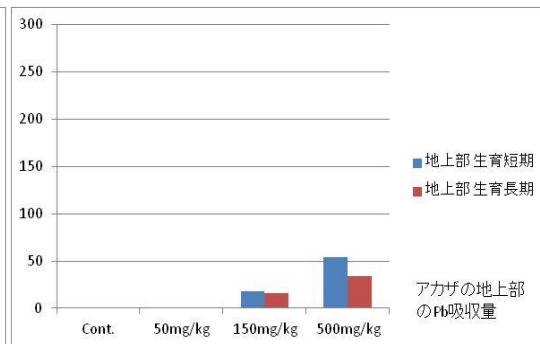


Fig.3 Pb absorbed amount of the leaf and stem

2) Study on the hot environment relaxation effect brought about by orbital greening

The surface temperature remained low in all the time zones except for the morning where the rainfall occurred, with respect to the non-greening section in the greening section. It is understood that the temperature of the greening section is also low at the height of 100 mm. Moreover, the temperature of the greening section continues to be low at night. It compared the cooling effect on the vicinity of the ground surface. Cooling time of 330 minutes at the greening section and 220 minutes at the height of 100 mm on the ground surface was confirmed(**Fig.4**). Both the ground surface and the height of 100 mm showed that the greening section had longer cooling time than the non-green section. It is a photograph taken by thermography. The greening plot was 7.2 degrees lower than the asphalt section and 4.4 degrees lower than the non - green section. The environmental temperature at 12 o'clock was 38.7 degrees(**Fig.5**).

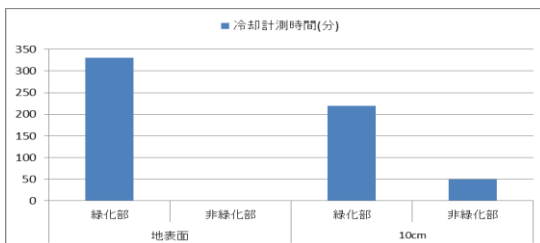


Fig.4 Cooling effect by Orbital Greenery

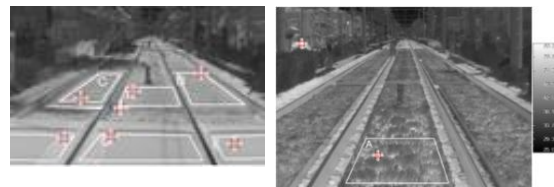


Fig.5 Thermography of orbital greenery

3) Storm water retention and penetration in the planting bases of urban district

3)-1 Condition of rain water retention in the planting bases of the housing complex

Soil wetness at the depth of 7.6cm was influenced by the evergreen trees and the vertical structure of the vegetation, and the water movement to the deeper point was smaller in the green unit with high coverage of grass or moss on the ground surface (**Fig.6**). In the greening bases with high coverage of deciduous trees, which has high sky ratio, more water tends to be stored in the deeper soil layer. On the other hand, in the unit with high coverage of evergreen trees with low sky ratio, water was kept near the surface of soil, which was especially influenced by the moss cover on the ground. From above, it was considered that the soil compaction by the roots of evergreen trees near the ground surface and the vegetation coverage on the surface could restrain the water penetration in the soil.

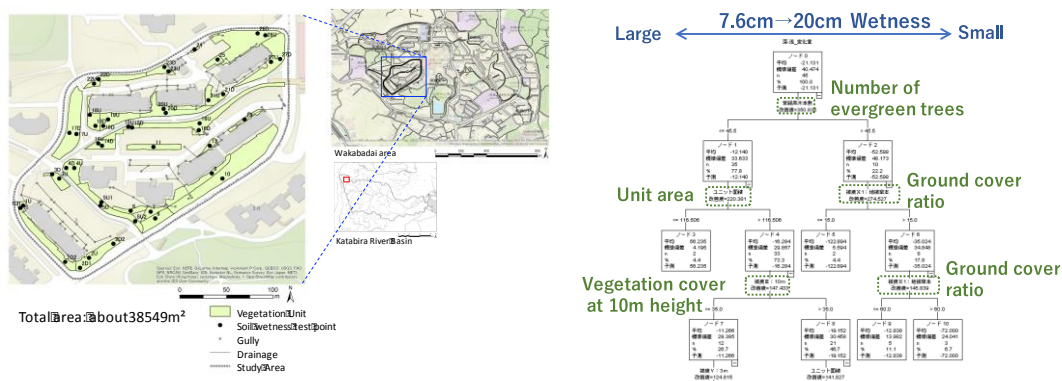


Fig.6 Vegetation units (left) and the variables related to the water penetration in the soil (right)

3)-2 Water penetration characteristics in the planting bases of greenway in the upland urban area

Water permeability was higher in the bamboo grass unit, well-managed bamboo forest unit, and Quercus forest, and the soil hardness was lowest in the well-managed bamboo-forest (**Fig.7**). On the other hand, in the no-managed bamboo forest and the inner part of the Quercus forest, water permeability was lower. It was considered that the high water permeability in the well-managed bamboo forest was affected by the picking of the soil and the restraint of the root density, beside the low water permeability in the no-managed bamboo forest and the Quercus forest was affected by the root compaction in the ground and the solidification of the surface soil by treading stress.

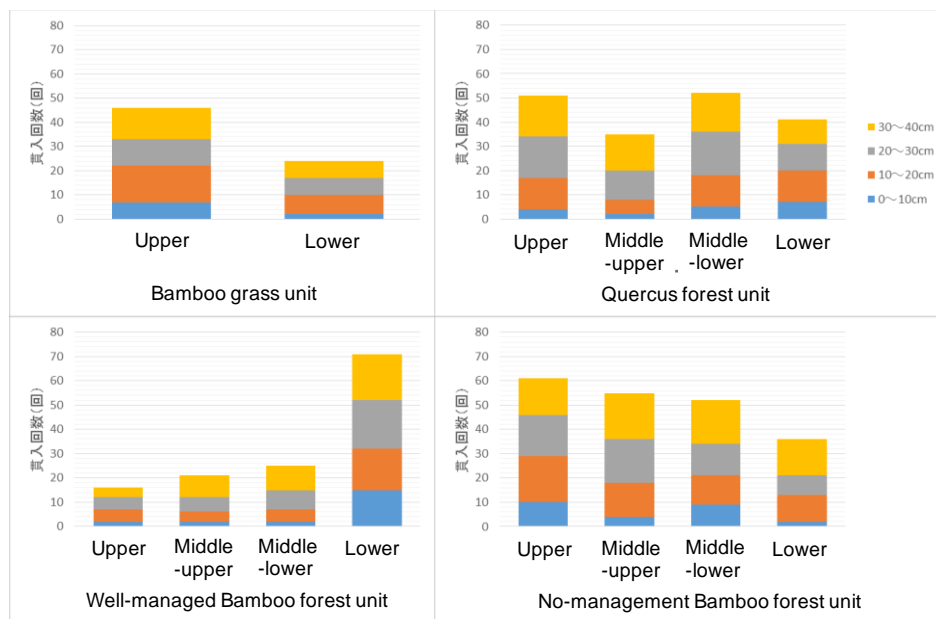


Fig.7 Number of indentation times by the penetration test (left) and the water permeability (mm/hr;right)

4) Co-establishment of urban ecological network and urban heat mitigation

As the result of line census, 712 butterflies of 18 species were observed. The most frequent species was Common Bluebottle (*Graphium sarpedon*), which accounted for 49% (347 individuals), and Pieridae (Small Cabbage White (*Pieris rapae*), Eastern Pale Clouded Yellow (*Colias erate*), Common Grass Yellow (*Eurema hecabe*)) accounted for 28% (188 individuals). Species diversity

was related to the vegetation cover ratio of low grass and the hierarchical structure of vegetation, and there was no direct relationship between species diversity and the thermal environment (**Fig.8**). Therefore, it was considered that the diversity of butterflies is characterized by the mixture of the grassland species, which are mainly affected by the existence of grasses. By the classification of the green segments in streets and open spaces, it was considered that the reduction of solar radiation by tree canopies is important in the segments with high isolation, such as in unused ground. In the segment which is composed only of the homogeneous street trees among the buildings, variety of grasses in the planting spaces of street trees was thought to be important as the food sources of butterflies (**Fig.9**).

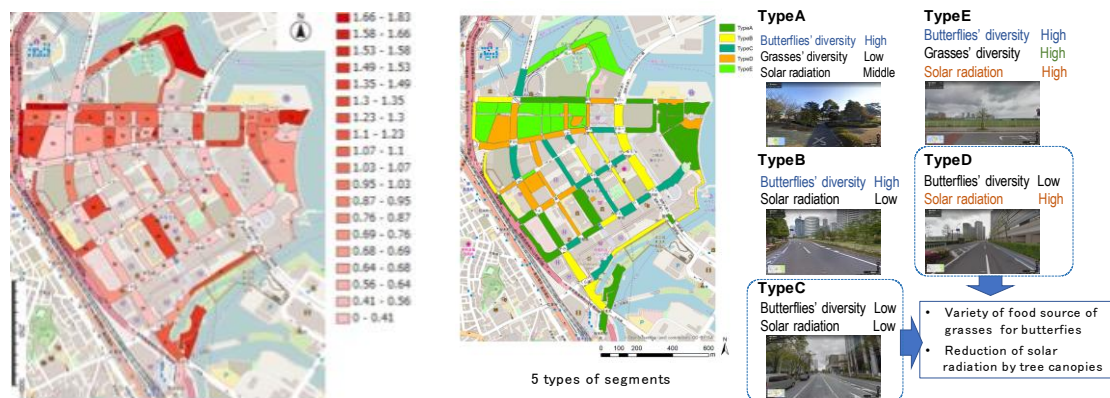


Fig.8 Species diversity of butterflies **Fig.9** Segment types classified by the relationship among butterflies, vegetation and thermal environment

4. Conclusions and Future Development

2 studies were introduced from the angle of the effective land use and environmental improvement. Absorption of Pb of *Chenopodium* was admitted by a fight remediation experiment and it's also possible to use it for a purge of Pb soil pollution of depth 1~2m.

On the other hand, cooling effect of the neighborhood environment by the orbit greenery was inspected.

About the water retention and water penetration in the greening bases of urban district, characteristics of the water retention and the permeability in the surface soil were grasped, targeting the planting bases urban district in hill and the street trees in upland. Henceforth, the effect of the physical structure of soil, including the grading record, and the root system should be examined.

About the co-establishment of urban ecological network and urban heat mitigation, the effect of the vegetation was larger to the butterflies' habitation than that of the thermal environment. As the future task, the influence of the thermal environment to the butterflies' habits in the similar vegetation conditions should be clarified concretely.

References

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