History and Subjects of Rainwater Harvesting and Wastewater Recycling in Japan

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Abstract

Based on the documentation and research results of authors etc., the history, present condition and future subject of the rainwater harvesting and wastewater recycling in Japan are described.

As history, the measure against a flood of a river in the 16th century, the object for water supplies in the rice agriculture performed in the agricultural area even now, and the water service technology from the 17th century to the 19th century are described. Moreover, the changes for water supplies in buildings from the 20th century are described.

And decision of the circumstances where the rainwater harvesting and wastewater recycling in Japan came to be performed from around 1980, the water quality and technical standard accompanying this are described.

A future subject is drawn from these results of an investigation. It is a measure to dealing with global generating of a flood and a drought according to a climate change, and the water reservation at the time of a disaster, and it is the establishment of a technical standard, technical sharing and the consideration of regionality about the subject of rainwater harvesting and wastewater recycling.

Keywords

Rainwater Harvesting; Water Recycling; Japanese History

1. Introduction

The problem of the climate changes and water preservation including the paper of Brazil and Portugal in the CIB W062 2011 poses a large problem in the world. Although Japan goes into much rainfall as compared with other countries, the amount of water that can be used per person is small. So, by present day, the measure against rain water and drainage reuse are performed.

While explaining the history of the measure against rainwater and drainage reuse in Japan, the trend of each country and a future subject are described.

2. History and climate about river improvement and irrigation of Japan

About the name of a place described below, the map of Figure-1 shows a place.

General Shingen Takeda (1521-1573) of the Age of Civil Wars and a Kai country (present Yamanashi Prefecture) has advanced the river improvement enterprise. The measure technology to the flood by the heavy rain called “Shingen Zutsumi” : river bank is famous. Moreover, a reservoir and a bank called "Waju" nationally and the “Ushirui” which are one of the spur dikes were made (Figure-2).

Japan is clear in change of the four seasons from the first, and a rainy season, a typhoon, and melted snow supply a lot of water to the area.

The precipitation of Tokyo is shown in Figure-3. The typhoon has an important duty which brings Japan a lot of water, though what occurs in about 26 pieces per year, and passes through Japan (Figure-4) causes many flood damage, and Figure-5 shows total snowfall of the Yamakoshi observation poin. Total snowfall amounts also to 1200 cm in the 2011 fiscal year. The rainy season in June is the important time in irrigation of a paddy field. For example, in the terrace paddy field in the Yamakoshi area, water is led in a horizontal well, water is dropped to a level difference, and the paddy field is irrigated.

From the first, many water service had secured groundwater as a head makes a dam in the upper stream with the increase in population, or aggravation of water quality, sends in water in a river, makes tap water in a water purification plant, and supplies water to a wide area increasingly on a pipeline. The dam that supplies water to the metropolitan area is shown in figure-6. The dam is useful not only reservation of water resources but for river improvement, such as flood defense and prevention of a mudflow. Moreover, electric power is also supplied by waterpower generation. However, the rate of the waterpower generation in electric power of Japan is not so large (Figure-7). Although the water wheel (Figure-8) was put on the stream and it was once used as power, most present age is not used. Instead, small scale hydropower attracts attention.

The technology of water service is also old. The Tatsumi city water in Kanazawa City pulled the pipe of the stone 15 km in 1632, and had sent water to the Kanazawa castle

by back siphonage. Tamagawa waterway in Tokyo was bearing the water service of the population of the Edo 1 million people said to be 43 km of waterway in 1653. However, in the detached island in Nagasaki Prefecture or Okinawa Prefecture, rainwater may be used even now including drinking water.[7),8)] Water is sent to the part on the pipeline from the mainland.

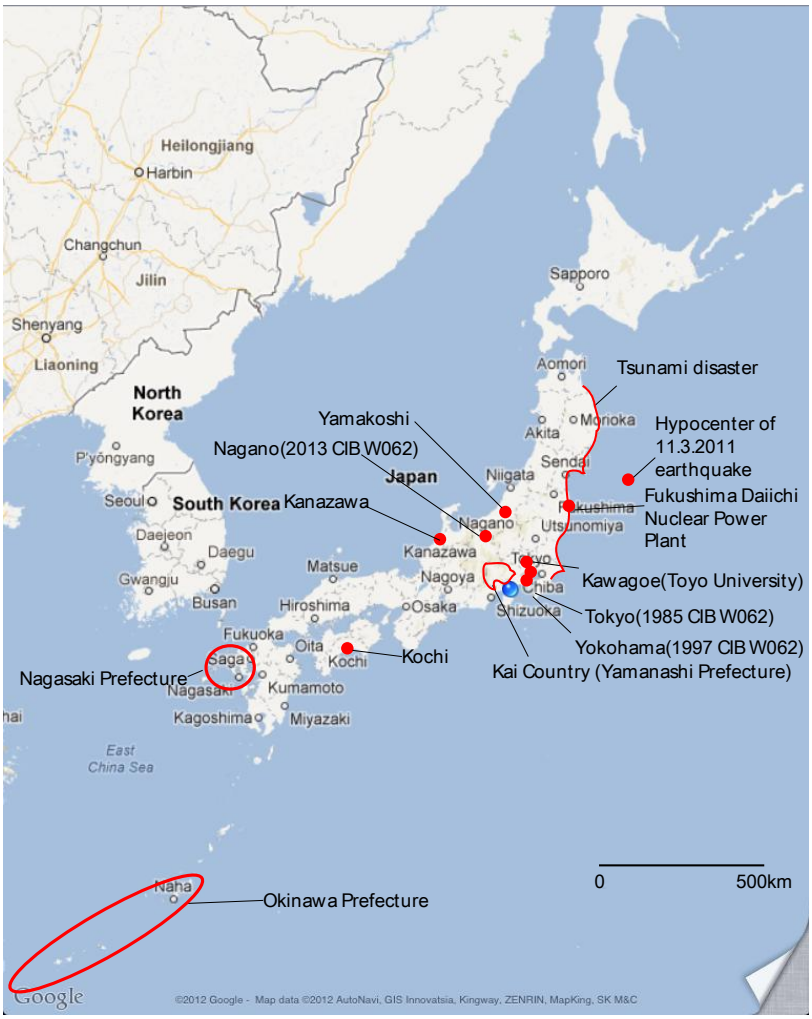


Figure-1 The name of a place to introduce

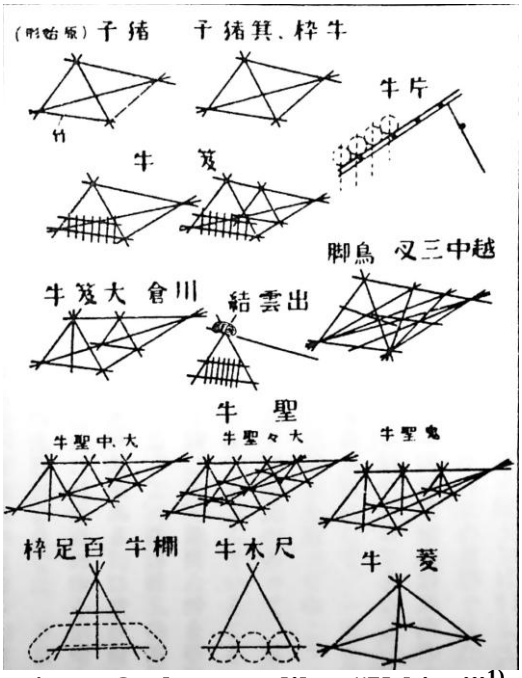


Figure-2 The spur dikes "Ushirui"[1)]

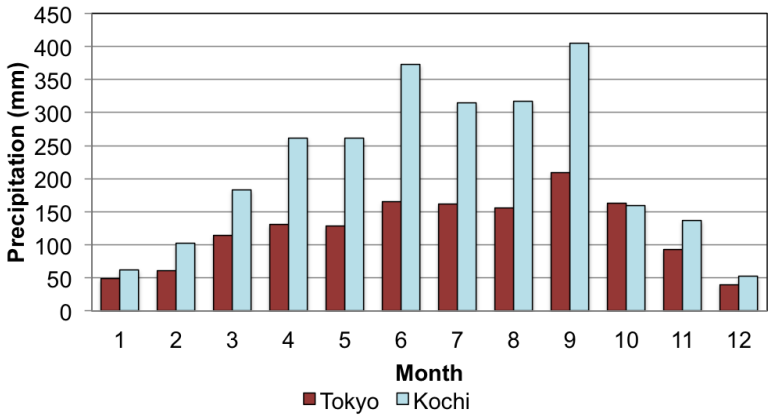


Figure-3 Precipitation of Tokyo and Kochi [from data 2)]

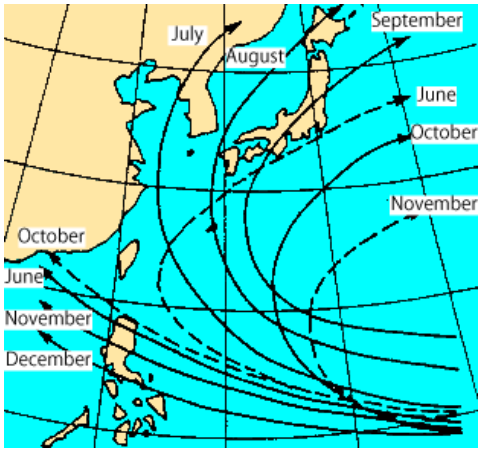


Figure-4 The course of a monthly typhoon [3)]

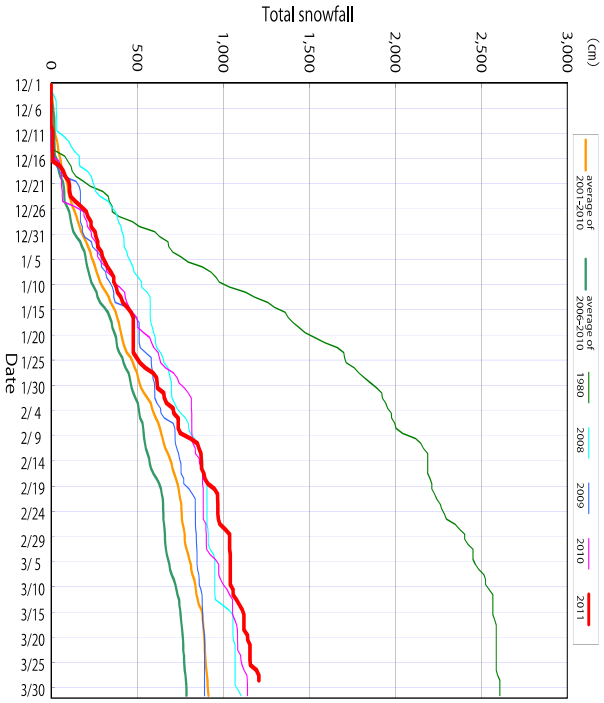


Figure-5 Total snowfall of the Yamakoshi observation point [5)]

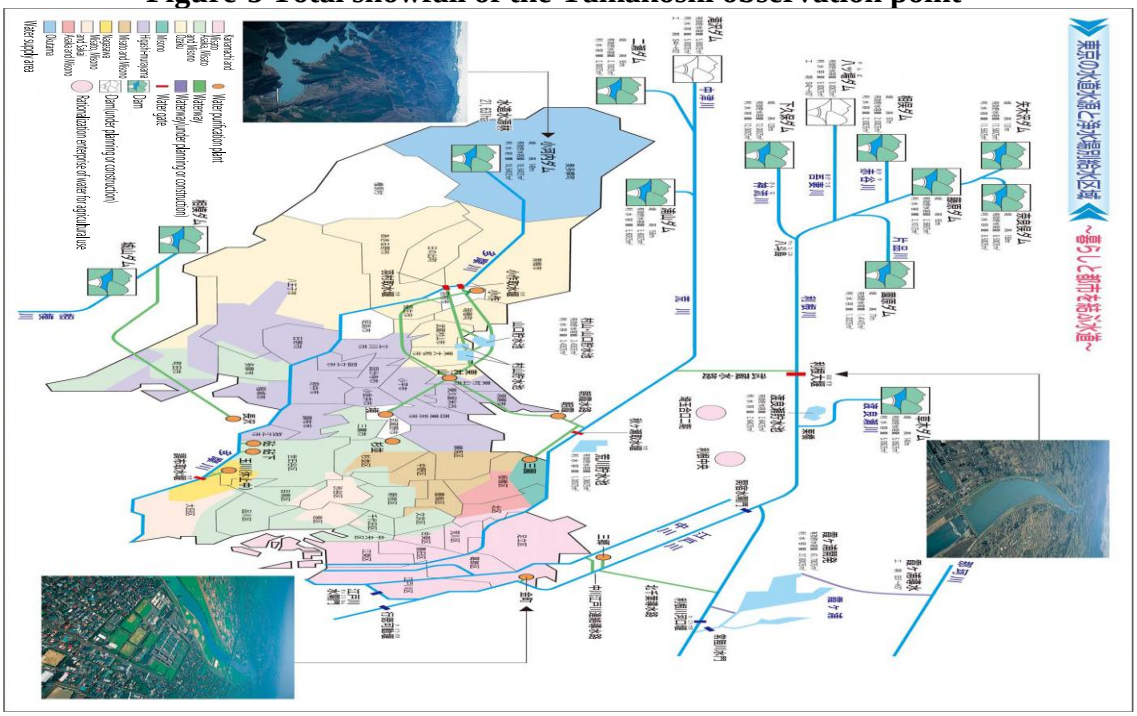


Figure-6 The source of tap water in Tokyo, and the water supply zone classified by water purification plant [6)]

3. The time of reuse and recycle water

Political change called the Meiji Restoration to 1968 in Japan happened, and, also in water service, modernization was advanced. Yokohama City in 1887, Hakodate City, Hokkaido in 1889, and Hadano City, Kanagawa in 1890 of modern water service are early introduction.

On the other hand, reservation of the head according rural areas to a well had continued for a long time. A water service diffusion rate is shown in figure-7. Opening of traffic of water service continued expanding a city and population.

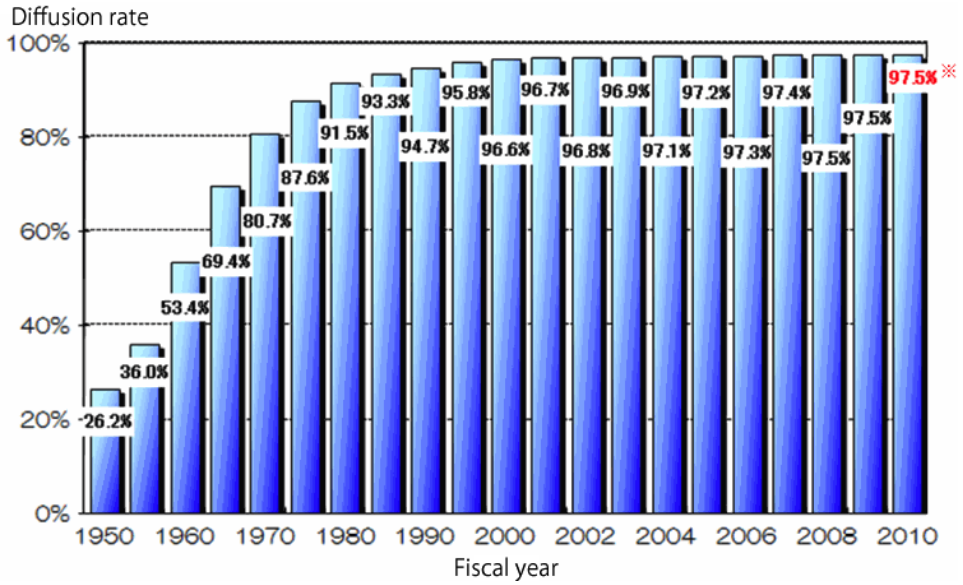
Applying from around 1900 in 1963, Japanese drinking water was supplied from water service, and, on the other hand, the rinse water of the toilet was supplied from groundwater. However, land subsidence occurred in pumping of groundwater and pumping of groundwater was forbidden from 1962 in Tokyo. Furthermore, the population of the city in Japan grew rapidly and a water shortage produced it. Moreover, urbanization progressed and the flood by a flood also occurred frequently.

Under such circumstances, rainwater use and drainage reuse came to be performed around from 1980. In addition, as for rainwater use, rainwater underground osmosis as the rainwater storage and the groundwater occurrence as a measure against a flood will be performed simultaneously.

As an example, rainwater use was performed at the IBM Japan Iikura building in 1978. Moreover, rainwater use of the Sumo stadium (Kokugikan) was performed in 1984, and rain water use of TOKYO DOME (the first indoor baseball field in Japan) was performed in 1988. In TOKYO DOME, the rain which fell to 15,700 square meters which is equivalent to the abbreviation half of a roof is stored to the water tank under a stand seat, or the cook room drainage in a dome is stored. These were processed and it uses as water for toilets in TOKYO DOME.[10)]

Thus, the system that takes in rainwater use in a building taking advantage of the rainwater use by roof construction will spread. Change of the subsequent number of examples is shown in figure-8. Although 3,550 is attained to at the end of the 2009 fiscal year, if the adoption example in a single house is also included, the rainwater use system is introduced into much more institutions.

Then, the Ministry of Construction (that time) created the technical standard in 1981, and the Ministry of Health and Welfare (that time) created the waterworks-for-miscellaneous-use water quality standard in the same year. The Minister of Construction secretariat building and repairing department published drainage reuse, rainwater use system design criteria, and the description in 1991. Many books about rainwater use have been published from the 1980s.



Water service diffusion rate = the total water supplied population/overall population, However, total water supplied population = waterworks population + simple waterworks population + private waterworks population

Figure-7 Transition of a water service diffusion rate [9)]

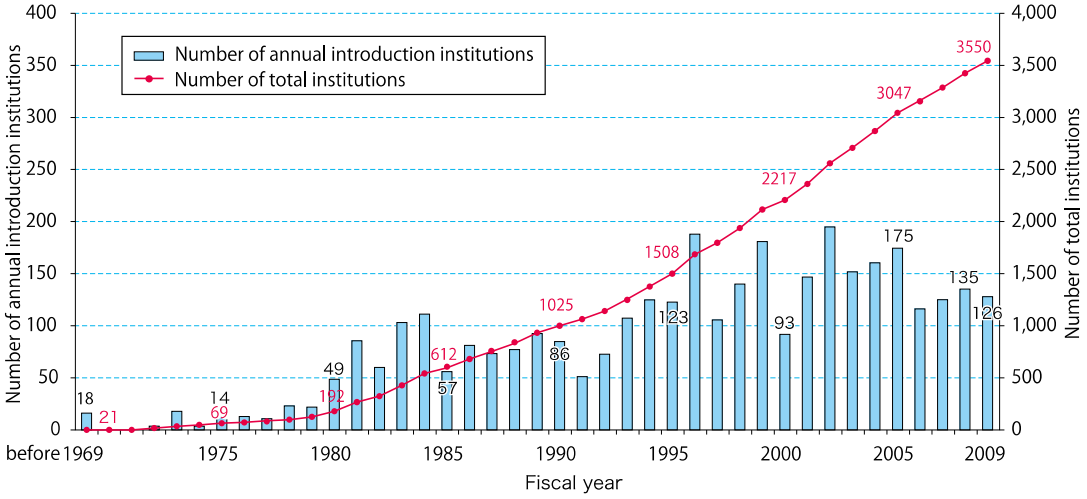


Figure-8 Transition of the number of rainwater or wastewater recycling institutions [11)]

4. Present measure and subject

Although the shower called “shower“ from before in a summer had occurred in Japan, the phenomena in which a lot of rain falls for a short time called “guerrilla downpours“ have occurred frequently recently. Hourly rainfall may amount to 100 mm or more.This is said to be what is depended on the situation where rain cloud progresses rapidly by the heat island effect. Moreover, it may also be in a cause that temperature is rising under the influence of a climate change. From the rainfall exceeding the design criteria of the present rainwater drainage being seen, the necessity for a new standard is imminent.

In CIB W062, Kiya and Uchida have announced as research on drainage recycle and rainwater use in 1994 (Brighton). Research and activity about rain water use were advanced at the time even in the Architectural Institute of Japan, and “Learning of rain architecture“ was published in 2000 and “Technic of rain architecture“ was published in 2005, and "Way of rain architecture " was published in 2011. Moreover, the "Guideline for rainwater harvesting architecture" was published simultaneously.

The "Rainwater Network Meeting" used as the place for performing information exchange / activity cooperation was founded in 2008 so that a citizen, a company, administration, a society, etc. of national every place might form a loose network and might spread mutual activity more effectively systematically. On the other hand, manualization of the rain water use system was considered in the field of building equipment from the Society of Heating, Air-conditioning & Sanitary Engineers of Japan , and "Rdain water use system design and business" were published in 1997. "The knowledge design, the construction, and the maintenance management manual of the business of rainwater use" which will be a revised edition of the writing 2011 more were published.

As research etc. with which a writer is concerned, the "rain water use program" was created by 2007 in development of the total energy simulation tool "BEST" of an outer cover and building frame, and equipment and apparatus [12)]. Moreover, it inquired as a rooftop gardening system which utilized rainwater about the measurement and evaluation of the rooftop gardening system which used the hydrophyte (Figure-9) in the 2009 to 2011 fiscal year [13)].

Furthermore, the infiltration of rainwater potential map in Hadano city is created now using GIS. While the possibility of prospective infiltration of rainwater or rainwater use is shown through this process of a series of, cooperation with the GIS data of a groundwater system is aimed at, and it is inquiring for the purpose of the construction and the city future model which realizes the healthy water cycle in the area being shown[14)].

Figure-9 Rooftop gardening system used the hydrophyte [13)]

5. Conclusions and future subjects

This report explained the historical circumstances which result in the river improvement, irrigation, and rainwater use or water recycle in Japan for which research in recent years and measure are introduced, and clarified the measure and subject to the water cycle centering on a building.

Now, flood and drought damage have occurred in various places globally. The measure in Japan also has the necessity of taking into consideration having happened in every corner of the earth. The importance of performing information sharing at international conferences, such as CIB W062, is recognized.

In Japan, it follows on the Great East Japan Earthquake that occurred in 11 March 2011, and the water reservation at the time of a disaster attracts attention anew. In the building of the skyscraper depending on especially water service and a sewer, etc., it is necessary to examine anew reservation of the water at the time of a disaster, rain water storage in it, and the necessity for practical use.

On the other hand, under the influence of the accident of a nuclear power plant, the radioactive material dispersed in various places and the problem on which a radioactive material is accumulated by the rainwater use system has arisen. It is necessary to gaze at a future trend about this.

6. References

1. Y. Nakai (1980): *Tatsumi City Water*
2. Ministry of Land, Infrastructure, Transport and Tourism (checked 01.08.2012): *Normal year precipitation, such as the prefectural capital*, http://www.mlit.go.jp/river/toukei_chousa/kasen/jiten/toukei/birn38p.html
3. *http://www.mlit.go.jp/river/toukei_chousa/kasen/jiten/toukei/birn38p.html*
4. Japan Meteorological Agency(checked 01.08.2012): *The number of generating of a typhoon, the number of approach, the number of landing, a courses*, http://www.jma.go.jp/jma/kishou/know/typhoon/1-4.html
5. Niigata Prefecture (checked 01.08.2012): *Total snowfall of the Yamakoshi observation point*,http://www.pref.niigata.lg.jp/HTML_Article/391/339/yamakosi20120328.pdf
6. Bureau of Waterworks Tokyo Metropolitan Government (checked 01.08.2012): *The source of tap water in Tokyo, and the water supply zone classified by water purification plant*, http://www.waterworks.metro.tokyo.jp/water/jigyo/syokai/img/2a_wide.pdf
7. Saburo Murakawa et al.(1986): *Research on the environment for water supplies of the residence in the Okinawa detached island Center on rainwater use*, Journal of Architecture, Planning and Environmental Engineering(No.368, pp.52-61)
8. Hironobu Hamasuna (2011): Investigation report about the rainwater use in the detached island in Nagasaki Prefecture: The present condition ten years after freshening equipment introduction, Environmental Research Report of Kyusyu Branch (No.50, pp.181-184)
9. Ministry of Health, Labour and Welfare (checked 01.08.2012): *Transition of a water service diffusion rate*, http://www.mhlw.go.jp/topics/bukyoku/kenkou/suido/database/kihon/suii.html

10. TOKYO DOME (checked 01.08.2012): *Rainwater use type industrial water system*, http://www.tokyo-dome.jp/csr/#csr2
11. Ministry of Land, Infrastructure, Transport and Tourism (checked 01.08.2012): *Water source in Japan 2011 fiscal year*, http://www.mlit.go.jp/tochimizushigen/mizsei/hakusyo/index5.html
12. Hiroyuki Kose et al (2008) : *The outline of the development rain water use program, the total energy simulation tool "BEST" of an outer cover and building frame, and equipment and apparatus (No.38)*, 2008 Annual Meeting of the Society of Heating, Air-conditioning & Sanitary Engineers of Japan, p.1153-1156
13. Hiroyuki KOSE et al. (2011): *Whole year comparison of controlling temperature and water balance at rooftop gardens with hydrophyte*, CIB W062 2011 37th International Symposium (Aveiro), E4, pp.326-330
14. Sho Komiyama et al. (2012): S*ystematic research on city planning corresponding to the global environment by environmental engineering collaboration (No.5) - creation of an infiltration of rainwater potential map*, Annual Meeting of AIJ

7. Presentation of Author

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