Vacant house utilization making use of the quarry groundwater in Oya area

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Abstract. In the Oya area of Utsunomiya City in Tochigi prefecture, because of the decline of the Oya-stone industry due to the rise of new construction materials and overseas production materials, abandoned agricultural lands and empty houses increased. However, recently in the Oya area, local government has tackled with the revitalization of the area utilizing abundant underground water of the Oya-stone quarry, which was once a facility of Oya-stone industry. For example, the place in which groundwater is accumulated in the quarry is utilized for underground lake cruise. Also, attention has been recently paid to the fact that the average water temperature of the quarry groundwater is about 7 degrees lower than that of ordinal groundwater, and business projects utilizing the quarry groundwater as a heat source for heat exchange system have recently been promoted by local government. As well as those approaches for revitalization, local government of Utsunomiya city has been tackling with reuse of empty houses. Therefore, this study explores the possibility of region revitalization utilizing regional resources in the Oya area, evaluating proposed empty house utilization that makes use of the quarry groundwater as a heat source of heat exchange system from the viewpoint of environmental burden.

In this study, we investigated buildings in the Oya area, and made a building information database. Assuming a case where a empty house is renovated and utilized as a restaurant that is short in Oya area, Eight buildings with different insulation performance and air conditioning method were modeled using the building information database. We evaluated the lifecycle CO2 emissions of those building models when utilized. As a result, it is estimated that about 70% of CO2 emissions can be reduced by improving insulation performance and air conditioning system and by utilizing quarry groundwater as heat source of heat exchange system.

1.Introduction
The Oya area of Utsunomiya City, Tochigi Prefecture has prospered as a town of Oya-stone, but due to the rise of new construction materials and overseas production materials, the Oya-stone industry has declined and the area of abandoned cultivation abandoned and vacant houses are increasing in the
whole area. Against this background, regional regeneration is required, and measures utilizing regional resources are needed. The purpose of this research is to improve the information on regional resources in Oya Ward and to verify and grasp the effect of Oya's vacant house in renovation using cold energy.

1-1 Background and Objectives of the Research
In recent years attractiveness as a sightseeing town has once again garnered attention and the project utilizing underground chilled water such as underground lake cruises and the utilization of Oya-stone mining site has been closed-up and now the center of Utsunomiya city, Activities of living activities are being carried out (Fig. 1).

In this research, we aimed to develop a digital area map that can be used as a decision support tool to compare the utilization of industrial activities community activities in Oya Ward, and to find the possibility of Oya's use of cold energy in Oya area.

2 Research outline
2-1 Scope of study
In this research, I surveyed the Oya Material Museum, Oya Town with Oya Kannon, Tage town, Oya-Main Street, Oya Town as a whole in the survey of building distribution, and In the building distribution survey, we surveyed the whole of Oya Town, surrounding Oya Ward and investigated.

2-2 Survey method
Field survey, interviews on the distribution of buildings and land in which users are absent and unused, such as buildings, Oya-stone processing plants, artificial structures mainly composed of Oya-stone warehouse, and the buildings, and We conducted two surveys on the distribution of buildings using GIS data from Utsunomiya City.

3 Survey results in Oya area
3-1 Oya Building Distribution Survey
The buildings in the survey area were 2655 buildings, including houses, factories, processing plant ruins. About 80% of the buildings are houses, followed by warehouses and processing plant, which shows the remnants that flourished in Oya-Stone. Oya area which began to attract attention as a sightseeing spot, but the store usage is very small, about 1.3% of the total.
The average of years of buildings age within the investigation range was about 51 years. The number of stone buildings was made more than 50 to 60 years ago than at present. In addition, the buildings of the Edo era exceeding 150 years of age were also scattered in Oya (Fig. 2). Wooden buildings were widely distributed (Fig. 3), the distribution of the stone building was distributed more along the Oya Kaido( Fig. 4), especially concentrated around Oya Kannon.

3-2 Evaluation explanation of buildings / land
In addition to basic information such as the structure and area of the building, in order to grasp the ease of utilization of the building, with reference to the guidelines for emergency risk determination, the deterioration situation of structural frameworks and fittings, information on land, related persons The survey sheet on which the hearing information was written was prepared and evaluated for each of the four items of "location evaluation", "landscape evaluation", "degree of maintenance evaluation", and "utilization evaluation" (Table 1).

Regarding distribution of points, when interviewing Oya person concerned in the Oya person concerned, the total of the four items was set to 100, the items allocated to each item were averaged and the allocation of points was made in consideration of importance

3-3 Building · Land Evaluation Result
Target buildings and land total 53, with breakdowns 40 buildings, and 13 land. The newer age is, the better the score is, and there are many good evaluations even for buildings with a longer than 100 years of age (Fig. 5). There were 20 items with a rating of 40 or more as high evaluation items, of which 6 were vacant houses. In Oya, there were many buildings with old-fashioned historical atmosphere, and there were places where buildings of each period of the Edo period to the Showa era were mixed on one site.

4. Building chart
4-1 Building / land use chart
We made a basic design of a digital map that allows you to display multiple information such as sightseeing information, buildings, land etc separately for each layer on the Internet. In the future transmit information by smartphone, PC, digital signage.

4-2 Creating a building chart

We organized the information on empty houses gathered from field surveys, produced a building chart for considering the information / state, utilization method, problem etc. of each building (Fig. 6), using GIS based on the information of this assessment sheets.

In this assessment sheets, details such as information on the building area, the total floor area, the structure etc. of the building, the owner of the land, the situation of the land, what kind of location are evaluated, and details on the evaluation, maintenance evaluation, landscape Evaluation, Utilization Evaluation are described in detail. Compared to the map we created, we described utilization considerations, radar charts, etc., and made parts to be a foothold for the future use of buildings, to make it look like, to be readily understood.

5 Case study on the reuse of existing buildings

5-1 Outline of existing building

We calculated the energy consumption and its relation on the assumption that conversion was done as an eating and drinking establishment of a building which is not currently used among the existing buildings of Oya who carried out the building detailed investigation. We also tried to calculate construction cost and life cycle cost, and also
examined the effect of renovation in Oya in terms of cost. For the refurbishment of buildings Table 2 shows the details of the reference model Table 3 shows the rough change points when renovating, and the plan view of the Oya building to be repaired is shown in fig7. It is assumed that this plan view is after change.

5-2 About Construction Energy
Construction energy is the total amount of energy consumed at the time of construction and it is assumed to repair the empty house in Oya this time so we shall not think about the construction cost of the framework and the cost of construction of the foundation and we will not consider the roof, window, insulation, equipment Items were examined. As the cost changes depending on the type of insulation and windows, we changed the insulation, window and air conditioning equipment for each model. Using the materials in Table 4, we estimated the eight models in total (Table 4). For the Oya model, It is a model that changed part of the wall to Oya-stone (10 m²). When calculating construction energy, we looked at the unit of energy consumption per industry related table in 2005.

The calculation results of each model are shown in Fig8. As the result was higher performance model increase construction energy. However, the Oya model, which changed part of the wall to Oya-stone, had about 2% less energy for construction in both air-cooling and water-cooling than the window model which had been improved both wall and window.

5-3 Operating energy
Calculation was made assuming that the energy calculation used guest seat air conditioning, kitchen air conditioning, electric energy of lighting, was driven. In addition, calculations were made assuming that the thermal loads obtained when trial calculations were supplemented with the cool energy of Oya. The results are shown in the graph of Fig. 9. By using Oya’s cold energy, it is possible to reduce it to a greater extent than the effect
of introducing insulation, and it has been found that the maximum reduction in energy quantity and CO2 emissions is about 71% (about 300 GJ / year).

5-4 Lifecycle energy

Within Construction, operation, refurbishment, disassembly, was focus on construction, operation, disassembly was focused on, the building life was 60 years and calculated. In addition, only the water-cooling type air conditioning system, the Cooling load shall be supplemented with cold energy of Oya. Unlike the construction energy, using the cold energy of Oya resulted in a calculation that reduces the energy by about 71%. In addition, it was found that the adiabatic model and the Oya model have the lowest lifecycle energy, and it can be expected that great effect can be expected even by changing the air conditioning of the existing model.

Based on the calculated results, the graph on construction cost and lifecycle cost is divided into air-cooled type and cold water type which are air-conditioning methods and summarized in a graph (Fig. 10).

Oya model was the lowest value for both air-cooled type and cold water type. For models with lower construction costs are considered to have higher life cycle costs and higher costs in the future.

Although cold water type requires construction energy, the life cycle cost is low, and the construction cost difference can be recovered in about 3 years. In addition, the adiabatic model and the Oya model showed no large difference. Although we changed some of the walls to Oya stone this time we can expect the effect obtained by increasing the proportion.

6 Conclusion

Oya has old building / vacant house and found that there are many things that could possibly be utilized. Furthermore, by using cold water of Oya, it is possible to reduce energy consumption and CO2 emissions by approximately 71%, and by using existing buildings in Oya and using cold energy. Construction energy and lifecycle energy are greatly reduced.

In the future, we will examine measures to effectively utilize these empty houses and open areas considering location environment and regional characteristics.

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