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EXAMINATION OF THE VALUE OF HISTORICAL AND CULTURAL HERITAGE LOCATED IN URBAN AREA AS ENVIRONMENTAL RESOURCES

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ABSTRACT: In recent years, many researchers have focused on the urban heat island, caused mainly by the increase in the artificial ground due to the development in urban areas. Several mitigation techniques have been utilized to reduce the temperature of the surrounding microclimate by installing green spaces in urban areas. To obtain greater benefits, the establishment of large-scale green spaces such as urban parks is more effective. However, designing urban parks in a big city is economically not efficient according to the limited land area and its high price. For that reason, roof and wall greening are one of the alternatives. Looking at the conditions in Japan, some areas with greens exist in the city, not parks but shrines. Shrines are religious landmarks based on the religion called Shinto. Shrines are often religiously and publicly protected and preserved in Japan. However, according to the lack of successors, or decrease in the surrounding population, or financial difficulties, the number is decreasing. The purpose of this study is to clarify the temperature-mitigating effect of the greens in a shrine and reevaluate it by the aspects of both cultural and environmental sides for future preservation. For this study, a shrine called Hakozakigu was targeted. It is a cultural heritage and also a huge green area that connects the seashore and the city center. The measurement was carried out in the summer of 2021. As a result, the mechanism of the temperature mitigating effect by the shrine was clarified.

Keywords: Land Use, Urban Heat Island, Green Space, Temperature Mitigating Effect

1. INTRODUCTION

In recent years, UHI has become a global problem. Therefore, as a countermeasure, installing green spaces in urban areas is being taken worldwide. A typical example is Singapore's national-level greening policy. Singapore is focusing on wall greening and the expansion of urban parks.

Typical examples of green spaces in urban areas of Japan, on the other hand, include parks and religious facilities, such as shrines and temples. Shrines generally have large-scale green spaces, so they are often traditionally used for festivals and other events, and so on. They are also utilized as a place for local gatherings and parks. Therefore, it can be said that those shrines play many roles other than religious symbols. A typical example of a shrine is Meiji Jingu, which is located in Tokyo. The satellite photo is shown in Fig.1.

In addition to playing a role as a vast green space in the city center, it also plays a role as a representative religious facility in Japan, with 3.1 million people visiting for worship every year. Due to changes in the times and the declining population, some of the shrines have ended their role and have been abolished or merged, and the number is decreasing. However, shrines are not only historical and cultural heritages but also work as green spaces which mitigate the temperature of the surroundings in a city. There are many studies relating to the temperature mitigating effect of natural resources.

Yokohari et al. [1] studied the effect of reducing the temperature of rice paddies located in residential areas in summer. Furthermore, Fukagawa et al. [2] surveyed several land-use types including rice paddies to determine the effect on microclimate in four seasons in developing areas in Japan. Therefore, to obtain greater efficacy, it is estimated

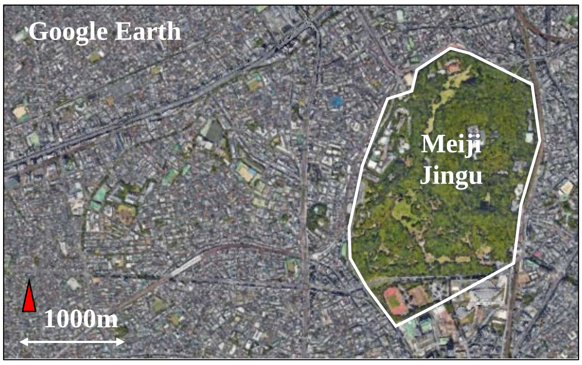


Fig.1 Satellite photo of Meiji Jingu in Tokyo

that the existence of large-scale green spaces is more effective.

Related examples of studies that examined the effect of temperature mitigation on energy efficiency in an urban green area, such as parks, are as followings. Anna et al. [3] examined the effectiveness of Bangkok's action plans on global warming. Jarotwan [4] examined the energy efficiency and environmental impact of the grocery store market in Canada. [5] examined the mitigating effect of climate change by studying an urban park and clarified its effects.

Fukagawa et al. [6] [7] examined the temperature mitigation effect of an urban park built in recent years with rainwater storage functions and parks with irrigation ponds. According to the studies, the occurrence prediction of UHI and the temperature mitigating effect of green areas such as parks were confirmed as appropriate case studies.

However, since the appearance pattern of heat islands differs depending on various influences such as city size, traffic conditions, and climate zones, further investigation is necessary. It is important to develop a quantitative understanding of the climate mitigation effect of green spaces, especially as a heat island mitigation measure.

The greening of urban areas and the construction of new parks are not easy, especially in Japan, as they impose a heavy economic burden. On the other hand, as mentioned above, there are many shrines, many of which have large green spaces. In addition, there are a total of 81067 shrines in Japan, and it can be said that they are valuable historical and cultural resources as well as environmental resources.

The following are examples of research that deals with the usage patterns and nature conservation functions of shrines. Hasegawa et al. [8] studied spatial characteristics such as usage and amount of greenery of shrines located in urban areas and reported on the current state of spaces as forests and squares. Koresawa et al. [9] regarded shrines with green spaces as natural environments and made proposals for conservation by analyzing the current situation. Ochiai et al. [10] conducted an actual measurement survey on the impact of green spaces on the urban climate at shrines located in Nagoya City and showed the effects of small-scale green spaces. In addition to traditional values, shrines have been attracting attention in recent years for their green space and mitigation effect on the surrounding microclimate.

2. RESEARCH SIGNIFICANCE

This research has two significances. The first is to obtain basic data on the environmental resources in the region as a countermeasure against high temperatures in urban areas due to the increase of artificial exhaust heat by air conditioning systems in the region. It can be said that there is great social significance in creating value for the environmental resources of the cultural and historical resources of shrines, which are many in Japan. The second significance is to reconfirm the value of the shrine and propose new value in future maintenance and conservation.

3. RESEARCH OVERVIEW

This research was conducted at Hakozaki Shrine, located in Fukuoka City. Fukuoka City is the largest city in Kyushu, located in the southern part of Japan, as shown in Fig.2. Fukuoka city has a population of about 1.5 million and is one of the cities with the highest population growth rate in recent years in Japan. Therefore, urban redevelopment is being actively carried out.

Hakozaki Shrine, the site of the survey, was established in 923 and has been a symbol of the region to this day. The satellite photo is shown in Fig.3. The site is arranged linearly from the torii gate on the sandy beach to the main road near the city center. Most of the site is always open to residents and worshipers, and in addition to its religious role, it also plays a park-like role.

Before Covid, a festival called "Hojoya" was held at the shrine in September every year.

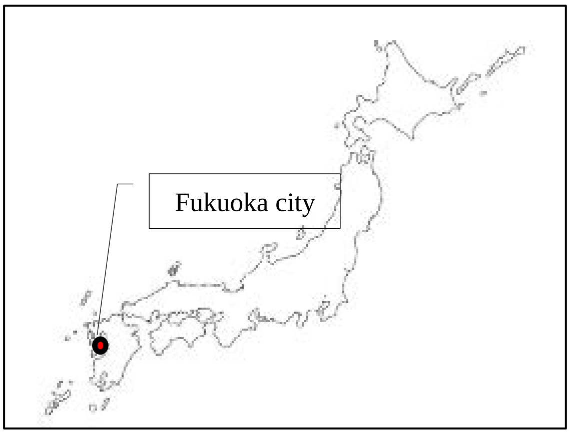


Fig.2 Location of Fukuoka city

Fig.3 Satellite photo of Hakozaki shrine

"Hojoya" is known as one of the most famous festivals in Fukuoka City. For that reason, it can be said that Hakozaki Shrine has great value as a religious, environmental, and tourism resource.

However, due to the influence of the redevelopment plan as a commercial facility on the site due to the relocation of Kyushu University, which was located nearby, the redevelopment of the surrounding area is progressing rapidly. It is presumed that it is also effective as a winding path because there are abundant trees on the site and the site is open straight from the coastline to the city area. Therefore, it is important to understand the impact on the surrounding microclimate when considering the conservation of the Hakozaki Shrine.

Fig.4 Measurement instrument

3.1 Measurement Procedures

The measurement was carried out at 10-minute intervals by installing temperature loggers (Elitech-5 +) in and around Hakozaki Shrine for a total of 27 days from July 9 to August 4, 2021. For temperature measurement, a simple wooden Stevenson screen was installed at each measurement point. The photo of the measurement instrument is shown in Fig.4. For meteorological data other than temperature, measurement data by the Japan Meteorological Agency was used.

3.2 Overview of Measurement Points

The locations of the measurement point are shown in Fig.5, and the sky photos of the measurement point are shown in Fig.6. A total of 23 measurement points were set up in and around the shrine premises. However, ④, ⑤and ⑯are lost during the measurement. For that reason, data from a total of 19 measurement points were used in this study. The sky factor of each measurement point is shown in Tab.1.

Measurement t points ① to ⑨ are located at the location that leads to the city area ⑨ from the coastline of ① through the shrine grounds.

Fig.5 Location of each measurement point

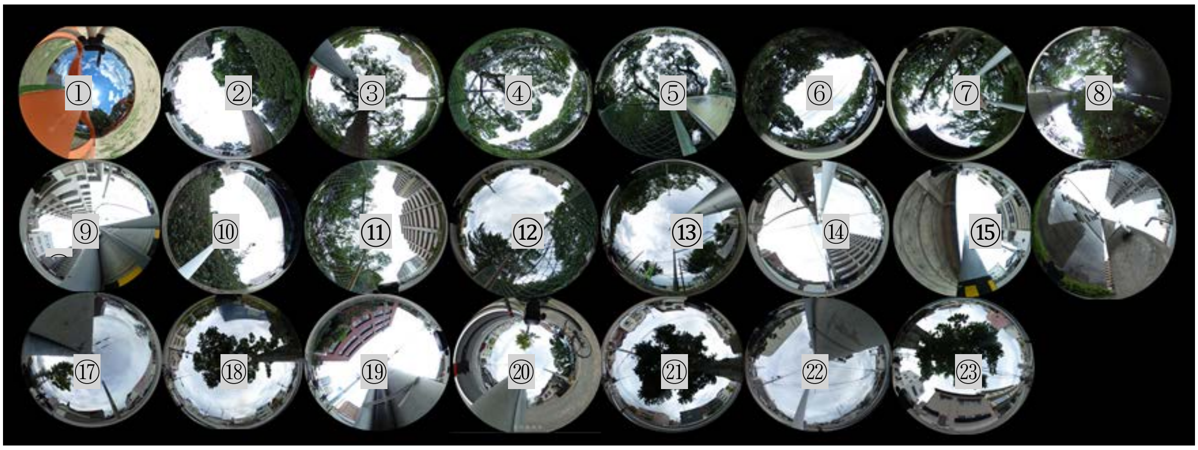


Fig.6 Sky photos of each measurement point

Table 1 Sky factor at each measurement point

	Green	Sky	Artifical structure	Others	Total		Green	Sky	Artifical structure	Others	Total
①	9.6	28.7	30.9	30.8	100	⑬	43.8	23.5	22.9	9.8	100
②	47.8	22.0	30.2	0.0	100	⑭	3.4	28.9	67.7	0.0	100
③	70.3	15.1	14.6	0.0	100	⑮	0.7	14.8	84.5	0.0	100
④	78.5	18.0	3.5	0.0	100	⑯	13.6	12.1	74.3	0.0	100
⑤	32.7	5.8	61.5	0.0	100	⑰	7.3	26.6	66.1	0.0	100
⑥	55.3	14.6	4.0	26.1	100	⑱	14.7	32.8	52.5	0.0	100
⑦	61.3	4.5	16.5	17.7	100	⑲	6.3	26.1	67.6	0.0	100
⑧	54.8	3.2	34.4	7.6	100	⑳	16.8	23.1	60.1	0.0	100
⑨	0.0	12.0	82.7	5.3	100	㉑	28.6	19.1	52.3	0.0	100
⑩	24.7	20.7	54.3	0.3	100	㉒	31.1	16.7	52.2	0.0	100
⑪	42.5	14.8	42.6	0.1	100	㉓	9.5	24.0	65.7	0.8	100
⑫	44.5	21.9	26.4	7.2	100						

*Gray shadings are lost measuring instruments

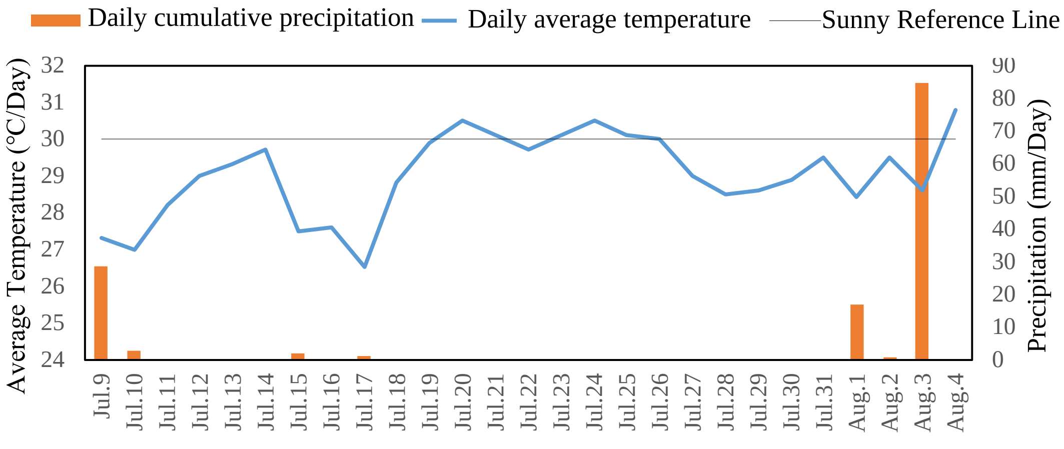


Fig.7 Weather overview during the measurement period

Therefore, it is expected to function as a sea breeze road. In addition, the amount of greenery in ② to ⑧ located on the shrine site is larger than at other points. Measurement points ⑩ to ⑯ It is installed along a narrow road in the northern part of the shrine. Therefore, the sky factor is low.

However, because it is located near the shrine, the proportion of greenery is relatively high except for ⑮ and ⑯, which are close to the city area. Measurement points ⑰ to ㉓ are installed along a two-lane road with quite heavy traffic in the southern part of the shrine. Therefore, the ratio of artificial structures is high. On the other hand, the amount of green is small.

4. MEASUREMENT RESULT

Fig.7 shows the results of the weather conditions during the measurement period based on the measurement data of the Fukuoka Meteorological Observatory, where located about 6 km away from the shrine (33 degrees 34.9 minutes north latitude 130 degrees 22.6 minutes east longitude). There was only a little rainfall

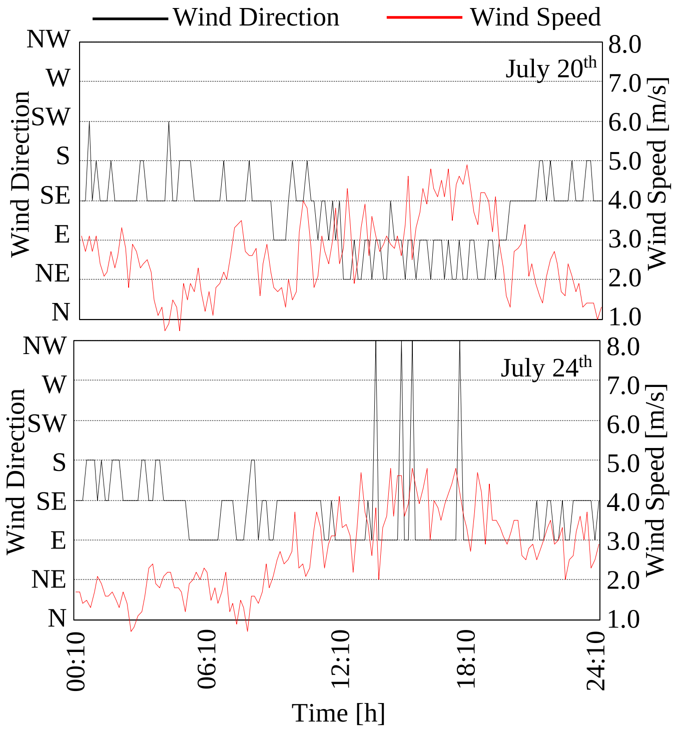


Fig. 8 Weather overview during the measurement period

during most of the measurement period, and the average daily temperature remained high.

4.1 Setting the Representative Days

In this study, for the purpose of grasping the influence of land use at each measurement point, the temperature data on the days when the daily cumulative precipitation is 0 mm for 4 consecutive days or more and the daily average temperature exceeds 30 ° C is used. Then, the above conditions were met for a total of 6 days,
July 20, 21, and July 23-26. Of these, the longest sunshine hours were 12.4 hours on July 20, followed by 12.1 hours on July 24, so in this study, these two days were considered representatives.

4.2 Wind Direction and Wind Speed

Fig.8 shows the time fluctuations of the wind speed and direction on July 20 and July 24, which are set as representative days. Looking at the wind speed results, the average is about 3 m / s. On the other hand, in terms of wind direction, the wind is southward at night and eastward during the day. Even though the measurement points are located near the coast, the influence of the sea breeze was small during the selected two representative days.

4.3 Temperature Fluctuations in Each Measurement Point

The time fluctuations of each measurement point on the representative days are shown in Fig.9 and 10. In the legend in the Figure, ○ indicates the premises of the shrine, △ indicates the northern part of the shrine, and □ indicates the southern part of the shrine. Looking at the daytime data, the temperature was high at ①, which is the closest to the coast, ②, which is close to the highway with heavy traffic, and ⑥, which is located at a relatively open point in the shrine.

On the other hand, the temperature was low at ⑦ and ⑧, where the amount of green was large among all the measurement points. In addition, the temperature tends to be low even in ⑨, which is surrounded by artificial structures and has a low sky factor. Looking at the results at night, when looking at the data on the premises of the shrine, the temperature tends to be low in ⑦ and ⑧, like the results during the day. On the other hand, in ①, where the temperature was high during the day, the temperature was low at night. Looking at the entire measurement points, the results were low at ⑫, ⑳, and ㉓.

From this result, the daytime results are strongly influenced by solar radiation, artificial exhaust heat,

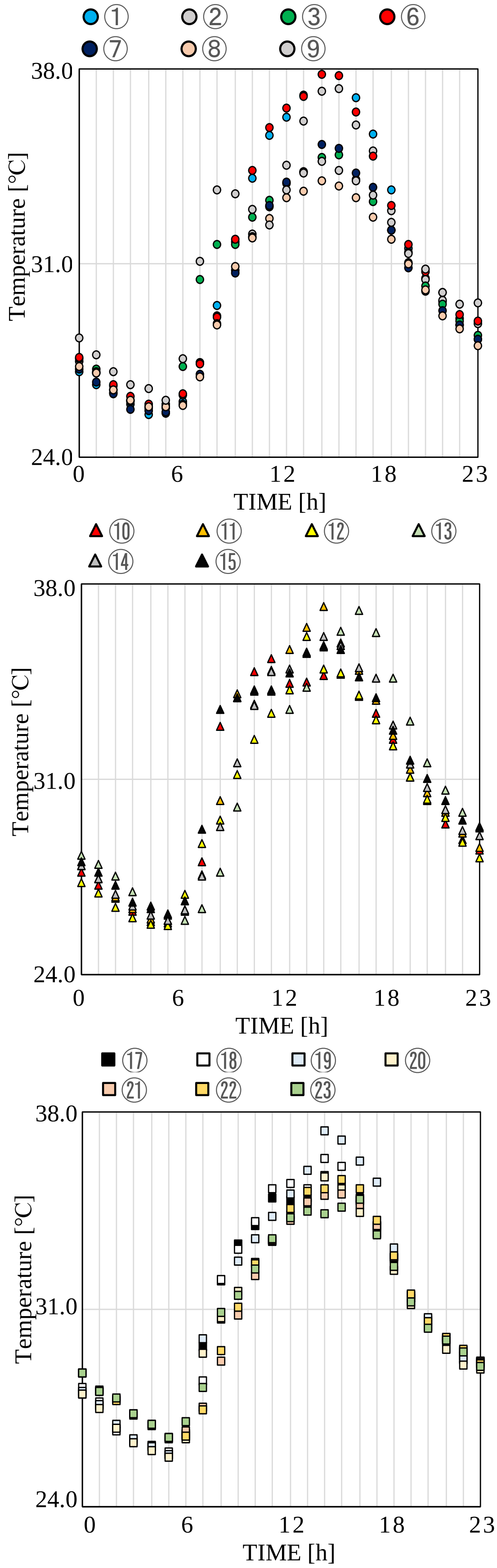


Fig.9 Hourly Temperature Fluctuation on July 20th

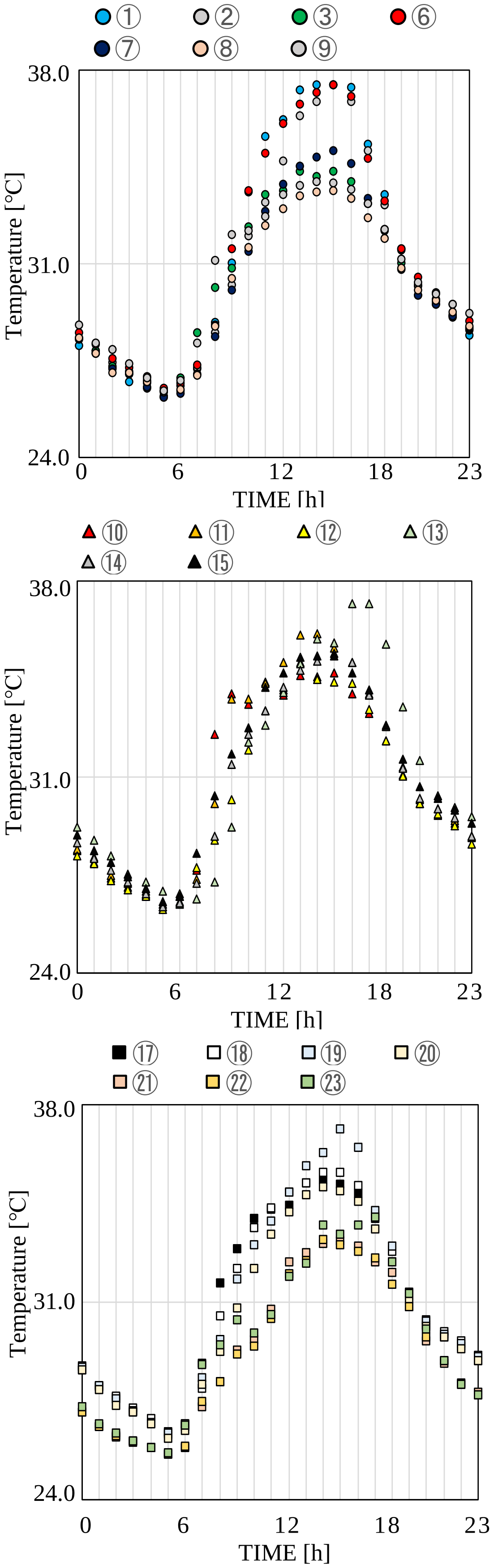


Fig.10 Hourly Temperature Fluctuation on July 24th

and the green space in the shrine. On the other hand, at night, when the atmosphere is stable, it is presumed that the outflow of cold air from the green space in the shrine to the surrounding area effects the surrounding temperature. In addition, it is assumed that the influence of the sea breeze on the microclimate around the shrine appears at night. Based on the above, from the next chapter onwards, we will visually grasp the influence of environmental factors around the shrine on temperature formation and quantitatively grasp the temperature formation tendency by processing statistically.

5. TEMPERATURE FORMATION TREND ANALYSIS BY CONTOUR MAP

Temperature contour maps were created to analyze the trend of temperature formation in and around the shrine premises. In creating the data, the nighttime data at 14:00 on a clear day and 12 hours later at 2: 00 a.m. when the atmosphere is stable were averaged. For sunny days, conditions were set for the third day or later of a period in which the cumulative daily precipitation was 0 mm for three or more consecutive days and for the average daily temperature to be 30°C or higher.

As a result, data for a total of six days, excluding July 22, was used from July 20 to 26th. After averaging the data at 14:00 and 2:00 at each measurement point, the measurement area was divided into 100 meshes and the results of interpolation processing are shown in Fig.11 and 12. Looking at the results of the daytime temperature formation tendency in Fig.11, the temperature is high on the seaside and along the main road with heavy traffic. In addition, the temperature in the green area of the shrine and its eastern side is decreasing.

Looking at the nighttime temperature formation results shown in Fig.12, a small low-temperature area can be confirmed from the seaside to the main road. In addition, it seems that the low-temperature area confirmed during the day on the shrine site is moving to the inland side. It is presumed that this is because the influence of sea breeze and green space appears clearly at night when the atmosphere is stable, and at the same time, it affects the temperature formation in the surrounding area.

6. MULTIPLE REGRESSION ANALYSIS ON TEMPERATURE FORMATION

To analyze the factors affecting the temperature in the measurement area centered on the shrine were examined using multiple regression analysis. The dependent variable is the 6 days on a clear day shown in the previous chapter, and the independent variables are wind speed, green amount, sky factor,

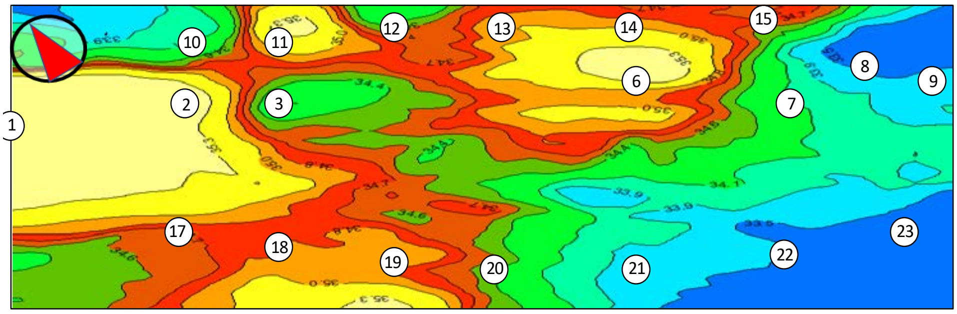


Fig.11 Temperature Contour Map at 14

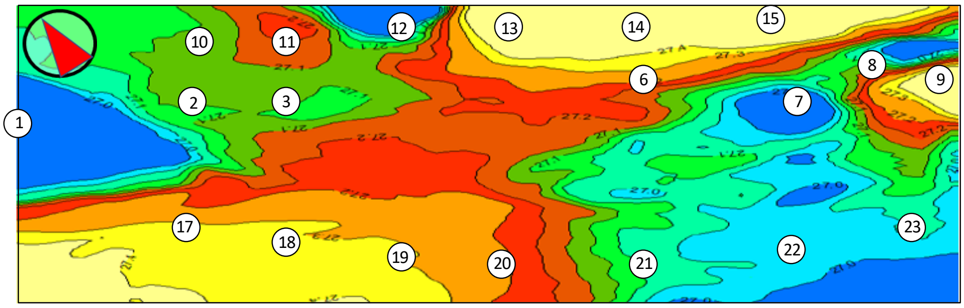
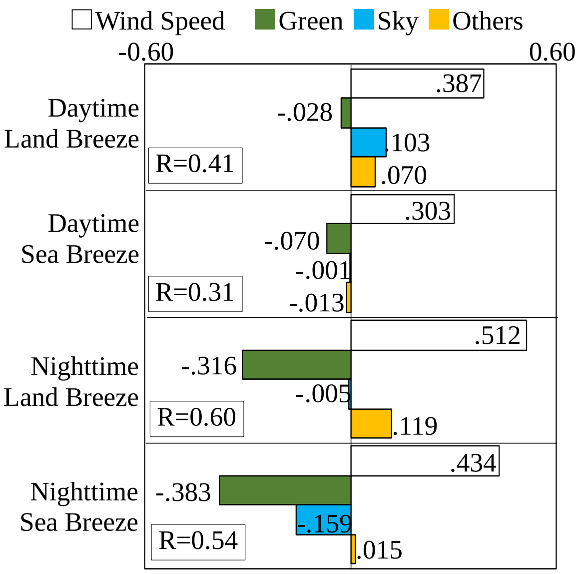


Fig.12 Temperature Contour Map at 2



and other sky factors. A total of 4 patterns were analyzed. The results are shown in Fig.13.

From this, the temperature reduction effect due to the number of green increases at night when the atmosphere is stable. On the other hand, the temperature tends to rise as the wind speed increases. However, in the case of sea breeze, the effect of raising the temperature due to the wind speed is reduced, and the effect of reducing the temperature due to the amount of green is expanding as compared with the case of la and breeze.

From the above, it can be interpreted that the temperature reduction effect of the site of the shrine, which has most of the green space in the measurement target area, has appeared. In addition, it is presumed that the effect spreads to the eastern area of the shrine during the sea breeze and that the most remarkable effect appears at night.

7. CONCLUSIONS

In this study, the results of examining the effect of the surrounding temperature mitigation effect of Hakozaki Shrine located in Fukuoka City in the summer of 2021, including the wind direction and wind speed, were presented. The results obtained are summarized as follows.

1) In the survey area, the effects of artificial waste heat centered on the arterial road and high temperature due to the artificial covering surface appear strongly during the daytime. Also, even within the shrine premises, the temperature tends to be high when the sky factor is high.
2) At night, the effects of greens in the shrine are clearly visible, and when affected by the sea breeze, it seems that the temperature reduction effect is spreading to the surrounding areas.

As previously mentioned, it was shown that the shrines surveyed in this study have many trees on the premises and function as a winding path from the coastline. Furthermore, it was clarified the mitigation effect of the surrounding microclimate was a new function. For that reason, the result concludes that Hakozaki Shrine, which currently functions as a park and festival place in this area, is a resource that should be protected not only for its historical and cultural value but also as an environmental resource that mitigates the local outdoor thermal environment for the future.

8. ACKNOWLEDGEMENTS

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