DISCUSSION ABOUT THE RISK CONTROL IN LAKE BIWA BASIN BASED ON THE LANDSCAPE ARCHITECTURE

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ABSTRACT: Shiga Prefecture, Japan, is one catchment that constitutes a large basin surrounded by mountains such as Mt. Hiei, Mt. Hira, Mt. Ibuki, Gozaishodake and Suzuka Mountains.
In the center, there is Lake Biwa occupying one-sixths of the total area of the prefecture. Lake Biwa has been a precious water source for Osaka and Kyoto.
We created a landscape image of the entire catchment by overlaying the SRTM_DEM image measured by the space shuttle Endeavor in 2000 and Landsat image. From this image, we attempted to forecast the impacts on the regional environments due to the wind trail crossing Lake Biwa, microclimates along the lake coast, training at the time of typhoon visit, development of a large-scale housing complex, mega solar power plant project, and so on.
In order to foresee the regional environments and disaster risks, we believe that an extensive systematic structure including hydrology, remote sensing and geographic information system becomes necessary from now on.
Considering the disastrous cases in the recent several years in Japan such as landslides and flooding engulfing houses, understanding of detailed landscape architectures in each region is strongly encouraged from the standpoint of risk management when construction of a mega solar power station or a large-scale housing complex is planned on a slope of a mountain or a wetland regarded as a retarding basin.

INTRODUCTION

Shiga Prefecture is located almost in the center of Japan, and this area played many historical roles in the past. It constitutes a basin surrounded by mountains such as Mt. Hiei, Mt. Hira, Mt. Ibuki and Suzuka mountains, which were once the stages of history, and it holds Lake Biwa accounting for one-sixths the prefectural area. Rains falling in this district all flow into Lake Biwa and, from there, down to Seta-gawa, Uji-gawa and Yodo-gawa through Arai weir. These rivers are serving as valuable water resources for Kyoto and Osaka Prefectures.
Lake Biwa is the largest lake in Japan with its area of 670 km^2. It stretches 64 km from north to south and 23 km from east to west. Its average water depth is 41 m, impoundment is 275 hundred million m^3, average surface elevation is 84 m, and the maximum depth is 104 m, which is 24 m deeper than the sea surface.
Fig. 1 presents the Landscape architecture image of the whole Shiga Prefecture created by us based on SRTM_DEM.

The north side of Lake Biwa is a snow zone and cold snowmelt water flowing in along the bottom of the lake due to a differential density in February and March contributes to the activities of the biosphere on the lake bed. In March, raging waves sometimes appear due to strong winds blowing down from Mt. Hira located on the west side of the lake. A wind trail is also said to exist starting from Imazu on the west side of the lake towards Mt. Ibuki (Sekigahara) on the east side. In Kosei area along the west coast of Lake Biwa, winds blowing down from mountains often drive the railway shutdown.

Fig. 1 Landscape structure of Shiga Prefecture

This paper is intended to perform environmental analyses and obtain new knowledge from the perspective of risk management of the area using spatial data such as satellite images. Fortunately, the latest Landsat 8 satellite image data are present in the USGS website and we could use it in our analysis by downloading.

LANDSAT 8 THERMAL IMAGE DATA AND ITS PROCESSING

Fig. 2 shows a pseudo natural image of Landsat 8 satellite image observed on February 25, 2021. Thirty scenes of clear images without any clouds covering Lake Biwa surface are available in the recent 5 years. They were readily downloaded to the personal computer in our university. The "Arcgis" software supporting the data processing function in our university is also provided and we could perform advanced processing using this function.

To check the analytical precision of the thermal images, we attempted to calculate temperature distributions along the profile line and transverse line of the lake using the summer image (August 17, 2020) and winter image (February 25, 2021). The results are outlined in three figures in the next page.

Temperature changes along straight lines were determined assuming lines A-A' and B-B' as shown in Fig. 3 to investigate the temperature distributions along the horizontal line from north to south and the transverse line from east to west on the surface of Lake Biwa and temperature changes in the summer and winter. Figs. 4 and 5 show the

Fig. 2 Landsat 8 image taken on February 25, 2021

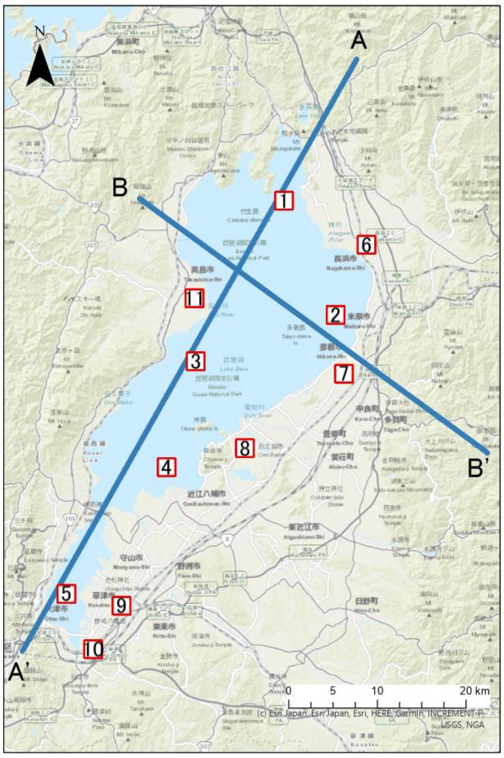

Fig. 3 Linear temperature distributions (lines A, B) on the lake surface

temperature changes along the line B-B' and line A-A', respectively. The data in winter was calculated from Band 10 of Landsat 8 observed on February 25, 2021, and that in summer on August 17, 2020. The horizontal axis in Fig. 4 and Fig. 5 present the distance (km) from the starting point and the vertical axis presents the temperature (°C). The temperature on the lake surface is estimated to be approximately 25°C in summer with variation of 2 to 3°C. Therefore, it can be said that there is a temperature change of 18 to 20°C on the surface of Lake Biwa between winter and summer. It is no doubt that the existence of Lake Biwa is contributing to cool breezes in the summer and temperament of snow coverage in the winter. The lines A-A' and B-B' in Fig. 3 contain the land areas on the lake coast including plains, mountain regions and valleys, and the temperature distributions corresponding to the complex geographical structure are shown.

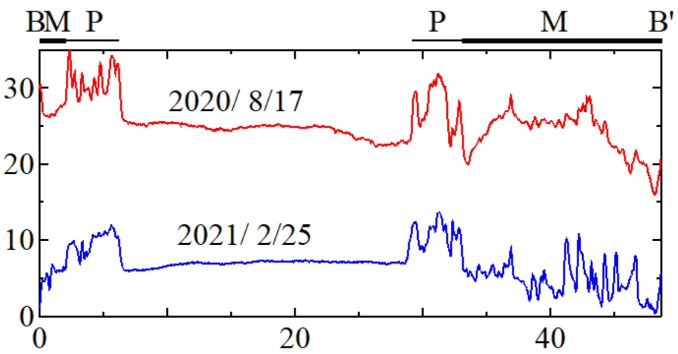

Fig. 4 Comparison of temperature distribution on line B between summer and winter

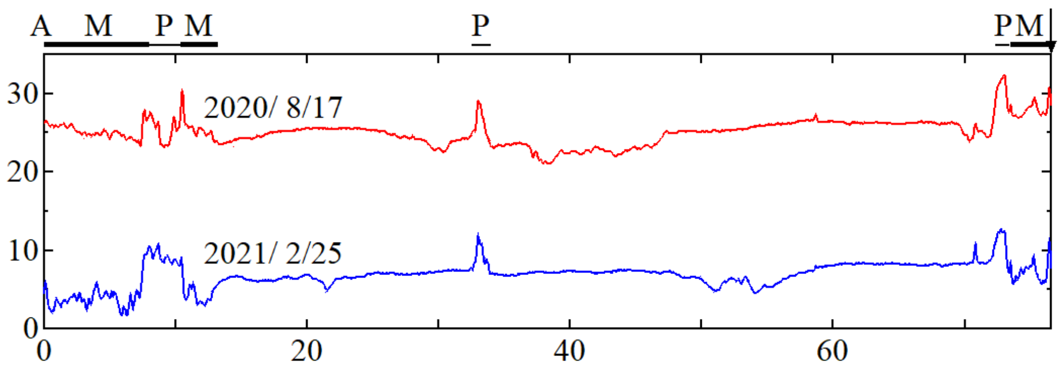

Fig. 5 Comparison of temperature distribution on line A between summer and winter

THERMAL ENVIRONMENT ANALYSIS ON THE SURFACE OF LAKE BIWA AND SURROUNDING AREAS

Thirty scenes of clear images covering the areas shown in Fig. 2 were confirmed from Landsat 8 observation satellite.

Here, five test areas were defined as shown in Fig. 6 in order to identify the characteristics on the surface of large Lake Biwa by dividing the lake into five blocks including the north, south, east, west and center; 1: Kohoku (north area), 2: Kotou (east area), 3: Kosei (west area), 4: Yasu (central area), and 5: Konan (south area). Then, pixel samples were extracted and temperatures were analyzed. To analyze the influence of the lake surface on the surrounding lands, six observation points were added; 6: Nagahama, 7: Hikone, 8: Dainakanoko, 9: Kusatsu, 10: Seta, and 11 Adogawa estuary. About 300 pixel values were converted to temperatures at each observation point and their averages were calculated. Table 1 presents the average temperatures.

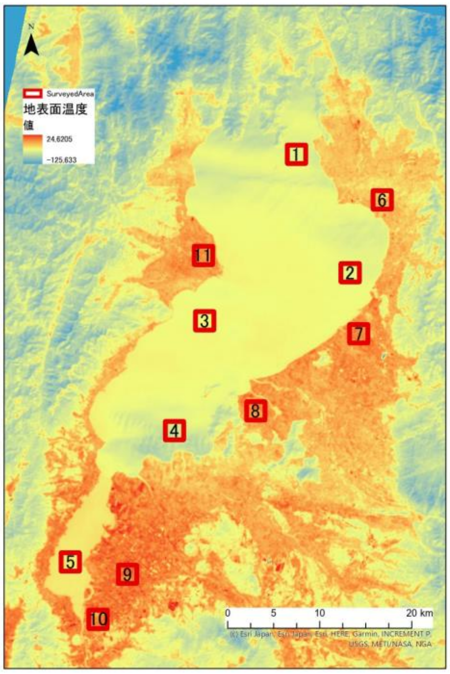

Fig. 6 Test sites on Lake Biwa and surrounding areas

Table 1 Estimated temperatures at the test points on lake water area and surrounding land areas

	Test sites on lake water areas					Test sites on land areas		
Area	Kohoku	Kotou	Kosei	Yasu	Konan	Hikone	Kusatsu	Adogawa
Date \ Site No	1	2	3	4	5	7	9	11
2019/**4/9** 10:28:05	7.0	9.0	7.5	8.8	11.0	19.9	17.9	10.7
2020/**4/11** 10:28:13	7.5	6.8	5.7	8.2	-5.6	22.3	12.2	0.2
2020/**4/27** 10:28:06	9.4	11.0	9.9	10.9	12.6	24.1	22.4	18.8
2021/**4/30** 10:28:09	12.6	11.5	12.6	12.7	14.4	17.3	14.5	20.1
2017/**5/5** 10:27:53	13.3	13.0	15.1	13.7	15.4	27.4	28.0	24.2
2019/**5/11** 10:28:07	15.8	16.1	16.8	17.1	18.6	31.8	34.3	27.3
2020/**5/13** 10:28:00	13.9	14.4	14.2	14.9	7.5	28.2	18.6	23.9
2018/**5/24** 10:27:29	15.1	15.6	15.0	16.4	18.8	27.0	31.5	23.0
2020/**5/29** 10:28:03	16.7	18.4	17.5	18.4	20.4	33.4	35.5	27.2
2021/**6/1** 10:28:20	17.2	18.1	18.4	18.4	19.6	32.6	34.2	28.4
2018/**6/25** 10:27:35	21.3	21.2	22.8	21.9	22.4	32.3	34.2	28.3
2021/**7/19** 10:28:32	23.6	23.3	24.0	23.5	23.7	31.9	33.6	28.7
2020/**8/1** 10:28:32	19.3	21.9	21.3	21.8	21.6	30.2	30.7	23.2
2017/**8/9** 10:28:36	21.4	21.3	21.8	22.2	22.1	28.9	25.6	24.3
2020/**8/17** 10:28:37	24.9	23.3	22.3	25.4	26.0	30.0	25.8	24.3
2017/**9/26** 10:28:47	20.8	20.9	21.2	21.1	21.2	28.4	28.8	25.4
2020/**10/20** 10:28:56	18.0	17.9	17.7	17.7	17.3	22.3	22.5	21.5
2017/**11/13** 10:28:51	7.5	13.3	13.6	13.6	13.4	16.2	16.0	15.0
2018/**12/2** 10:28:30	13.2	13.2	13.3	13.1	11.3	13.6	13.9	13.6
2017/**12/15** 10:28:46	8.6	9.0	7.8	8.2	6.0	7.5	8.6	7.5
2020/**1/6** 10:28:47	9.5	9.5	9.8	9.2	7.5	9.4	8.6	9.1
2021/**2/25** 10:28:36	6.2	6.6	7.2	4.9	8.0	13.0	14.3	12.4
2020/**3/26** 10:28:21	9.8	9.1	9.6	9.9	11.8	22.2	23.7	20.2

It is seen first from this table that the temperatures in 3 land spots are comparable from November to February but they start to rise in urban districts in March generating a difference of about 10 degrees in April. The difference between the water and land areas broaden in the same way to 20 degrees in the beginning of June. However, as the water temperature in Lake Biwa also rise steadily, the difference is reduced and fall into about 5 degrees in August. Fig. 7 illustrates the results in Table 1.

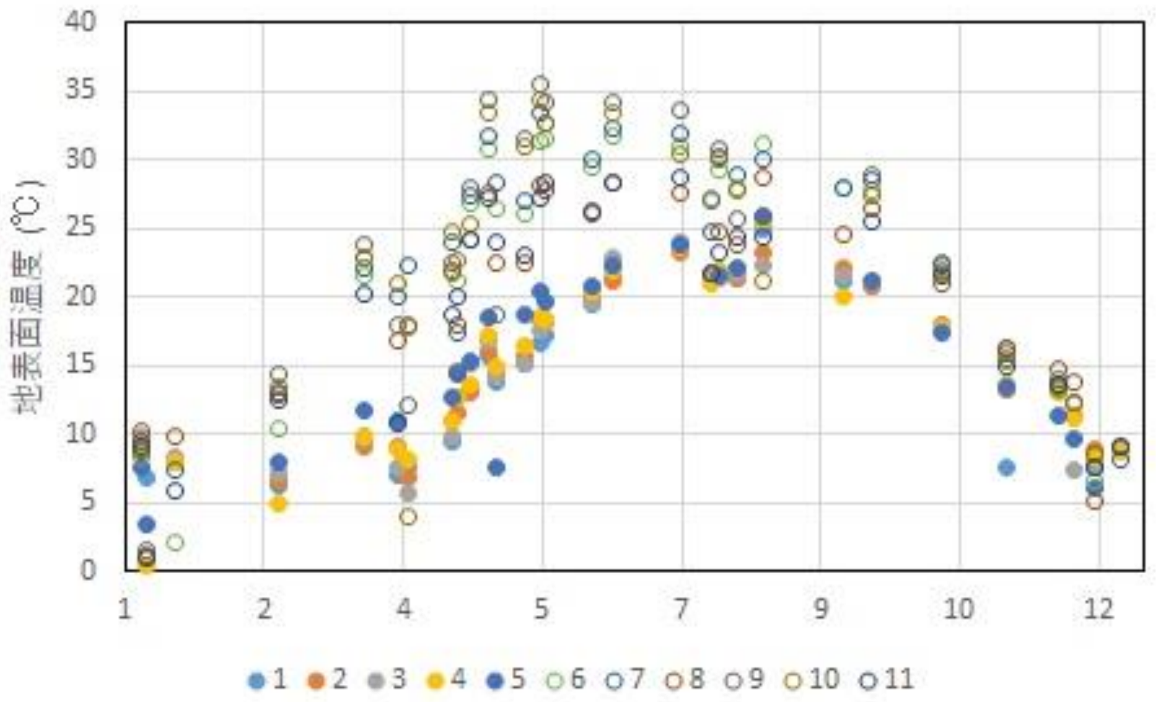

Fig. 7 Temperature changes at 11 test sites in the temporal order (horizontal axis: temporal axis by the observation date (month), vertical axis: ground surface temperature)

While there are differences of 4 or 5 degrees depending on the water surface area, this figure represents well the characteristic of the thermal profile that rises along with the season from 5°C in the winter to 25°C in the summer and lowers from fall to winter. The water temperature lowers after reaching its peak in August and becomes equal to that on the land in November. Although the peak of temperature is primarily expected in August in urban areas, it is seen in June in Table 1 deviating remarkably from that on Lake Biwa. Since the Landsat images were all taken around 10:28 and the daily temperature change has a peak around 13:00 to 14:00, it is considered that the temperatures determined from the Landsat images are those at the starting point of temperature rise.

One point to note is the test site 8 in the midst of the reclaimed farmland of Dainakanoko, where the temperature is lower than the urban areas indicating around 28°C even in the midsummer. Crops including paddy rice are cultivated from May to September and, thereby temperature rise moderating function seems to be acting. This is a point to pay attention in the future analysis as a buffer zone between the lake surface and land area.

TIME SERIES CHANGES IN TEMPERATURE DISTRIBUTION IN 5 YEARS

There were 30 scenes of Landsat 8 image data applicable here in 5 years from 2017 to 2021. Fig. 8 presents the temperature changes at the test sites 1: Kohoku, 3: Kosei and 5: Konan, in the order of observation dates.

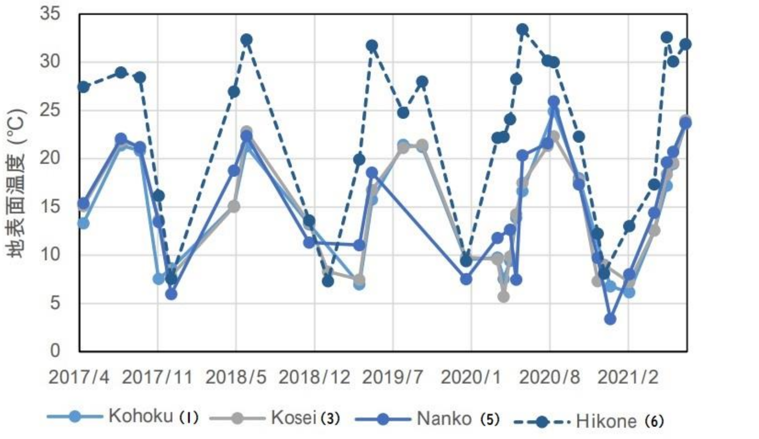

Fig. 8 Changes in water temperature in the past 5 years (land area in (6))

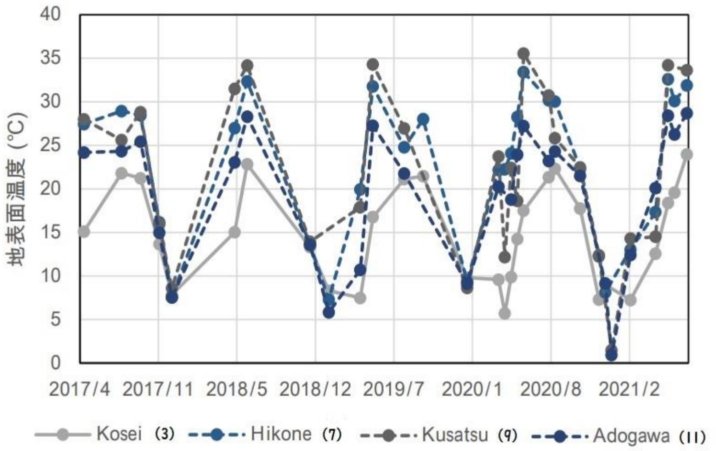

Fig. 9 Temperature changes in surrounding land areas in the past 5 years (water area in (3))

The temperature change at the test site 6: Hikone is also presented as a reference to see the difference from the land areas. While the graphs all show clear annual changes, the difference in temperature between the land and water areas becomes negligible in the winter season. The temperature in the land areas rises in May to August demonstrating the increase in temperature difference from the water areas. Fig. 9 presents the temperature changes at the test sites 7: Hikone, 9: Kusatsu and 11: Adogawa on the land areas around Lake Biwa in the order of observation dates. The temperature change at the test site 3: Kosei is also presented to compare the relation to the surface of Lake Biwa. The same trend as in Fig. 8 is noted here; the temperature difference between the water and land areas is negligible in the winter season but it is seen to extend from May to August.

CONCLUSION AND FUTURE PROSPECT

In the beginning, we aimed at information processing for the local risk management by detecting environmental factors from the landscape images of Shiga Prefecture as a whole. As basic data for information processing, Landsat 8 launched recently from NASA is existing and its data was downloadable readily and in large volumes. Fortunately, ArcGIS Pro 2.8.2, the most suitable software for the processing of the above data had been introduced to Shiga Prefectural University and the processing progressed efficiently. The function to instantaneously measure the temperatures on the water surface of large Lake Biwa was our first experience and it provided us with exciting outcomes. We could also confirmed the significant impact of the water area on the climates in the surrounding areas. Shiga Prefecture is said to have a wind trail blowing through from Imazu to Sekigahara. We would like to further analyze information such as satellite data in detail the roles of these mountainous areas are playing in the natural environments in the prefecture. Through such analyses, we believe that we could offer valuable information to the regional development plans in the future.

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