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Relocating the Kaohsiung Weather Station: The influence on Meteorological Observation Data

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Abstract

The purpose of this study is to explore the differences of meteorological data before and after the relocation of Kaohsiung meteorological station. It is divided into three parts. The first part is the background information, which explains the difference of geographical conditions between Qianzhen former station and Nanzih new station. At the same time, the location of Tainan and Yongkang stations as meteorological benchmarks is also described. Next, it is explained in two parts. The first is temperature. We are concerned about how different latitudes, land-sea location and altitude affect temperature data. Next is the dew point, which simply discusses the water content in the air.

Research motivation and purpose

The Kaohsiung Meteorological Station (Central Weather Bureau [CWB] - Taiwan) has moved from Kaohsiung City's Qianzhen District to The Metropolitan Park in Nanzih District of Kaohsiung City since July 25, 2022. It has been determined that the meteorological data at each of the different places differs significantly. The purpose of this study is to explore the influence of different geographical factors in close proximity on variables such as temperature, humidity and dew point by analyzing the resulting data of the two meteorological stations through an analysis of charts.

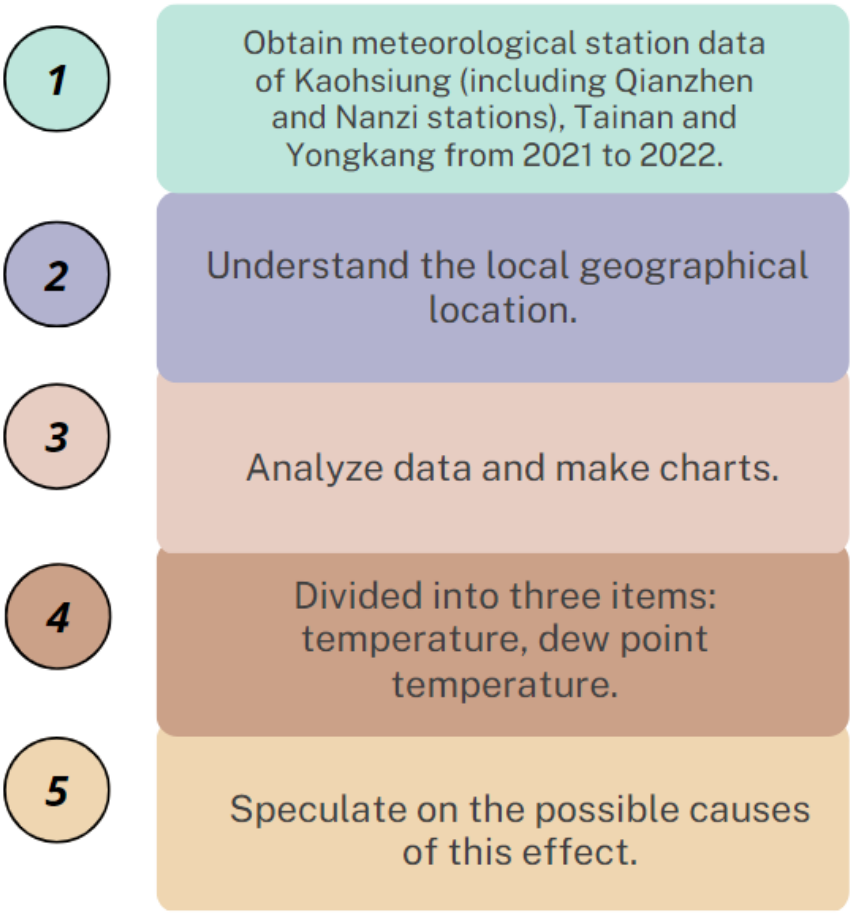
Research Questions and Hypotheses

1. Discuss the geographical differences between the former Kaohsiung Meteorological Station (station code 467440) and the newly relocated Kaohsiung Meteorological Station. (station code 467441)

2. Compare and analyze the relative air temperatures between the former Kaohsiung Meteorological Station and neighboring-vicinity meteorological stations.

3. Compare and analyze dew points between new and former Kaohsiung Meteorological Stations and adjacent-vicinity weather stations.

Research Methods and Introduction



(Figure 1.Research flowcharts)

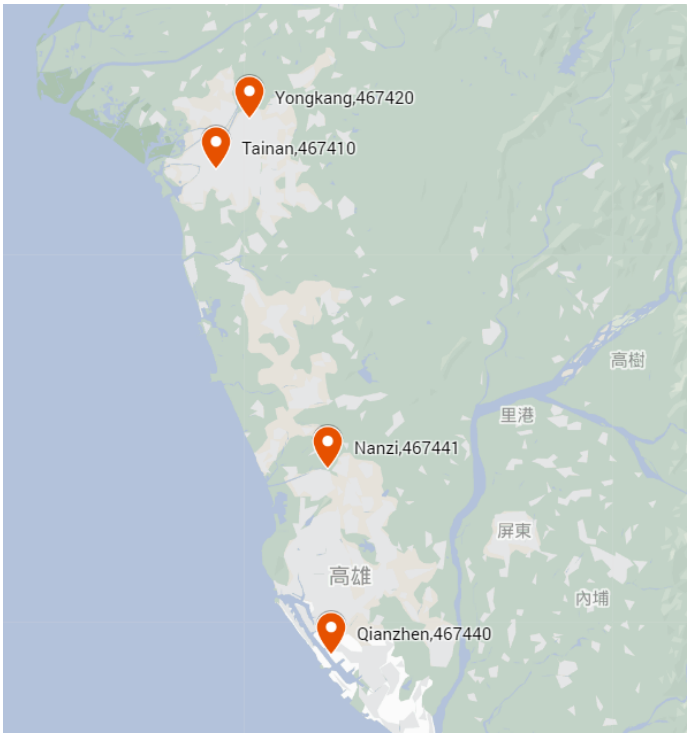
Research Data, Results, and Discussion

1.Summary of weather station backgrounds and investigation of relative geographical locations.

Research topics:

- 467440 (Qianzhen Meteorological Station – Former Location)
- 467441 (Nanzih Meteorological Station – New Location)
- 467420 (Yongkang Meteorological Station – Current Location)
- 467410 (Tainan Meteorological Station – Current Location)

The research topics are 467440 (Qianzhen Old Station), 467441 (Nanzi New Station). And 467420 (Yongkang Weather Station) ,467410 (Tainan Weather Station) are used as a standard in comparative analysis. All of the above are third-class weather forecasting agencies of CWB. The following is a diagram of the relative positions of three stations:



(Figure 2. Relative positions of four meteorological stations)

(Figure 3. The distance between coastlines and stations)

The former meteorological station (467440) in Qianzhen was inaugurated in 1973 to meet the metrological needs of local fisheries. The following is a sketch of the geographical location in the near vicinity:

(Figure 4. Geographical location diagram of the former station (467440) in Qianzhen District)

The meteorological station is adjacent to Qianzhen Fishing Port and Kaohsiung City Port, the largest fishing and logistics port in Taiwan. It is proximate to the open coastal waters of the Straits of Taiwan, with an altitude of 2.3 meters, which is the lowest found among the above four stations. According to Ming-dian Zheng, Director of the CWB, the reason for the recent relocation is because nearby structures directly affect the quality of various meteorological observation efforts.

The new station (467441) is now located in Nanzih District, and it was opened in 2022. The geographical diagram is as follows:

(Figure 5. Geographical location diagram of the new station (467441) in Nanzih District)

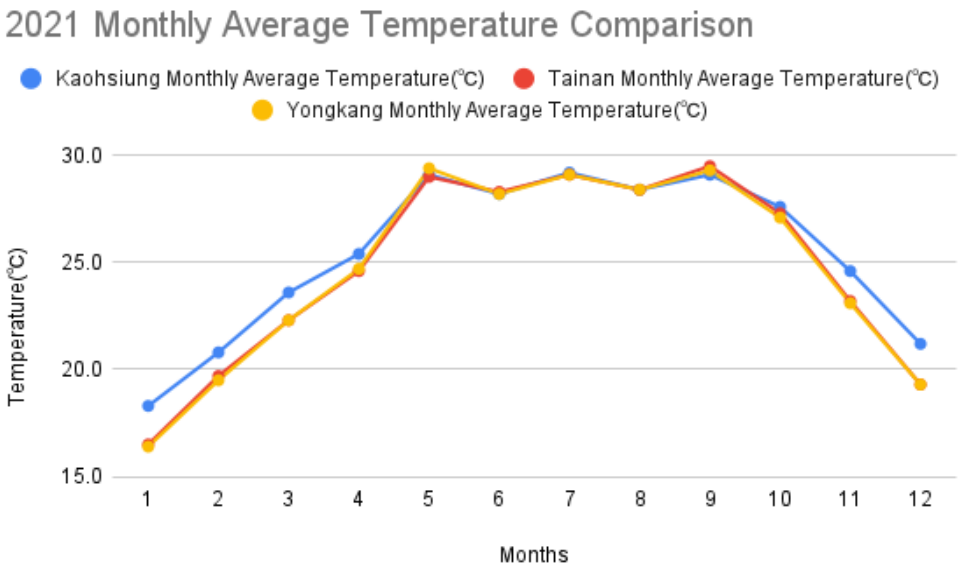
The area is adjacent to Kaohsiung Metropolitan Park and Houjin Creek, located in an interior land area, with an altitude of 11.8 meters.

2. Data description

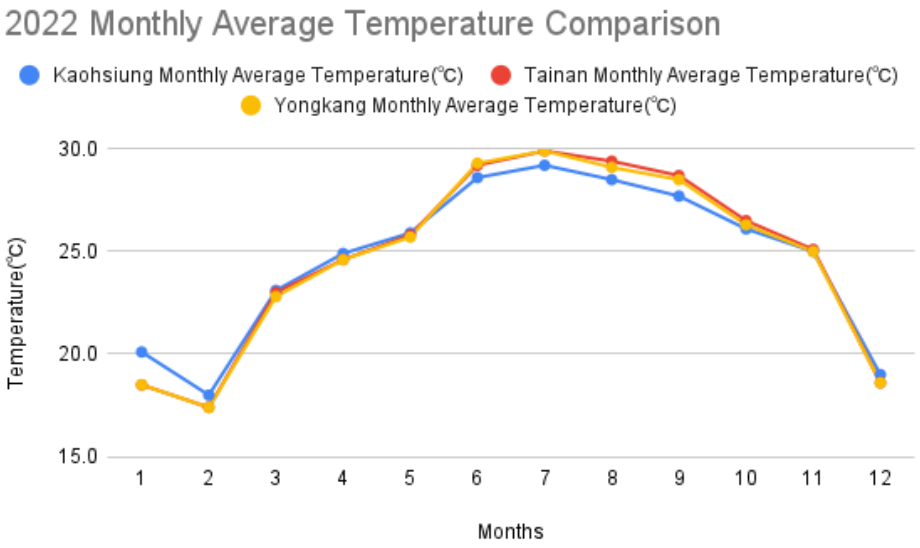
The data used in this study are data specific to the Kaohsiung City, Yongkang and Tainan weather stations (2021~2022). Among them, the observation data of the Kaohsiung City Meteorological Station from January 2021 to May 2022 represents the data of Qianzhen Former Station (467440). It has been the data of Nanzih New Station (467441) since June 2022. The charts used in this study are all hourly data and obtained by taking daily or monthly averages.

3.Discussion of the relative air temperatures

A comparative analysis of air temperature between former and new Kaohsiung City weather stations and adjacent weather stations.



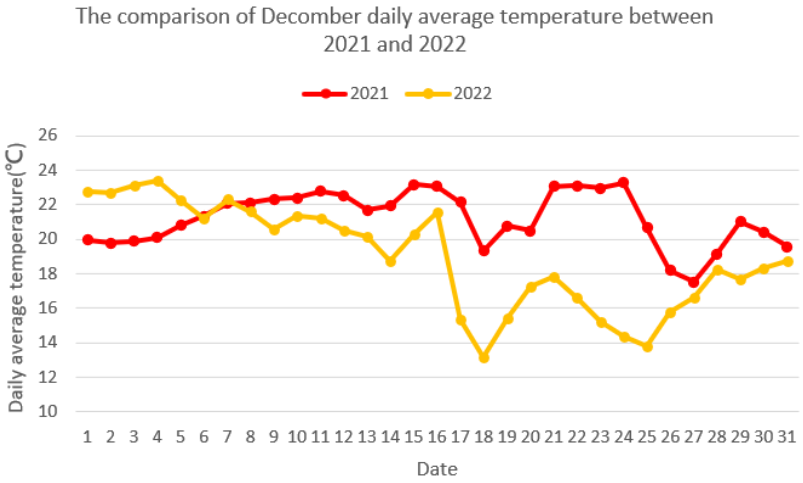
(Figure 6. 2021 Monthly Average Temperature Comparison)



(Figure 7. 2021 Monthly Average Temperature Comparison)

In the two charts shown above, the broken lines representing the two stations in Tainan almost overlap due to their proximity and relative sea level in Kaohsiung City is low. Under normal circumstances, the average monthly temperature of Kaohsiung City Station in Qianzhen will be higher than the broken line for the entire year of 2021 and from January to May of 2022. After June 2022, it is almost lower than the broken line. We can infer that the temperature measured at the new station in Nanzi is lower than that at the old station in Qianzhen.

With December 2021 and 2022 as examples, it is possible to observe the temperature trend.



(Figure8. Comparison of December daily average temperatures (2021~2022))

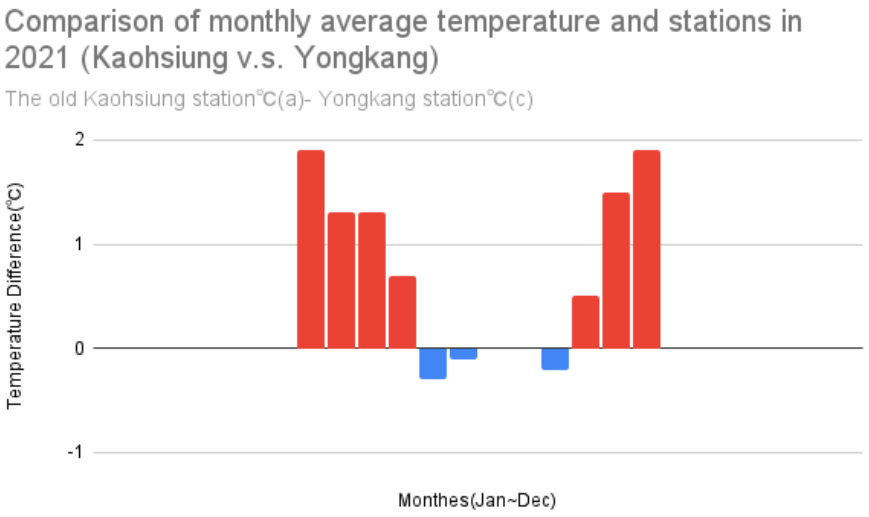
It is possible to ascertain that the average daily temperature for most days in December 2021 was higher than in December 2022. Also, the lowest temperature in this graph was measured on December 18, 2022, at the new station.

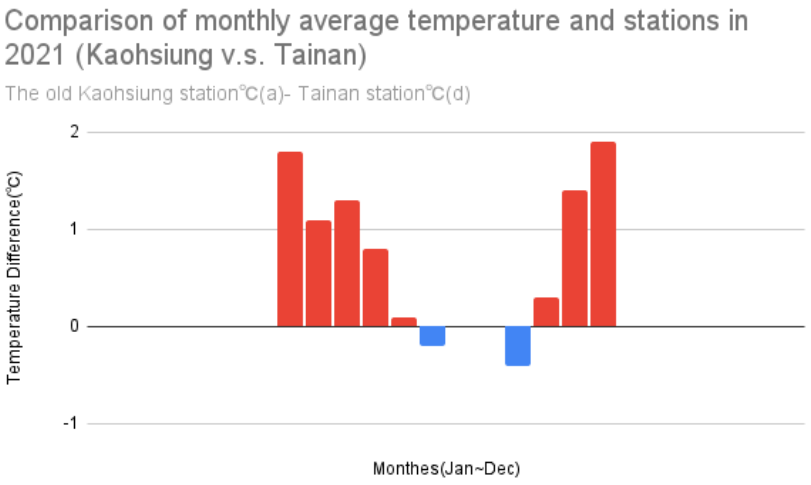
According to the above inference, due to the different specific heat properties occurring between land and sea. The temperature of Qianzhen Former Station (467440) located in proximity to a large body of water is generally on the high side because it is regulated by oceanic influences.

Moreover, it is observable from Figure 7 that the month with the coldest average temperature in Taiwan is usually January. However, in 2022, due to February's influence of the mainland cold air mass and the eastward movement of the cloud and rain area in South China, The CWB issued a special advisory report regarding low temperatures.

Comparison of monthly average temperature in 2021

2021 The average temperature	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
The old Kaohsiung station℃(a)	18.3	20.8	23.6	25.4	29.1	28.1	29.1	28.4	29.1	27.6	24.6	21.2
Yongkang station℃(c)	16.4	19.5	22.3	24.7	29.4	28.2	29.1	28.4	29.3	27.1	23.1	19.3
Tainan station℃(d)	16.5	19.7	22.3	24.6	29.0	28.3	29.1	28.4	29.5	27.3	23.2	19.3
a-c	+1.9	+1.3	+1.3	+0.7	-0.3	-0.1	0	0	-0.2	+0.5	+1.5	+1.9
a-d	+1.8	+1.1	+1.3	+0.8	+0.1	-0.2	0	0	-0.4	+0.3	+1.4	+1.9

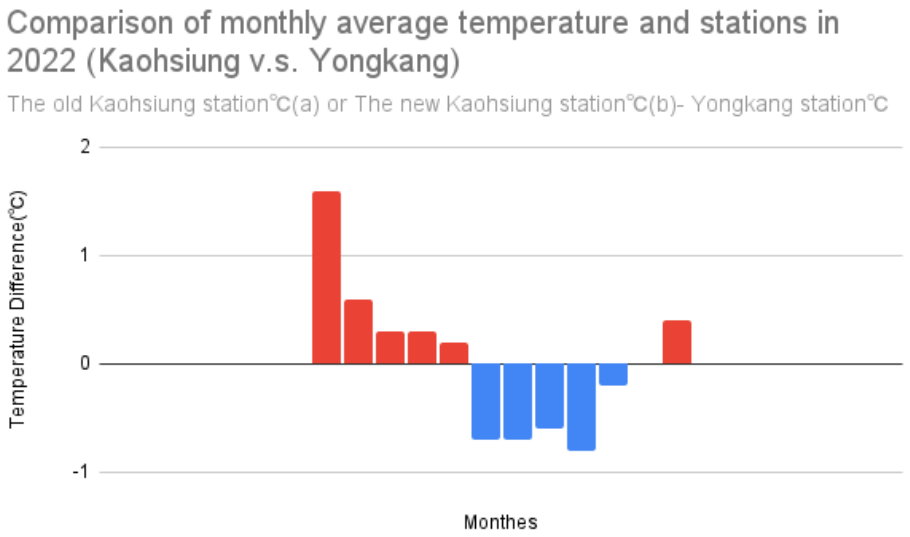


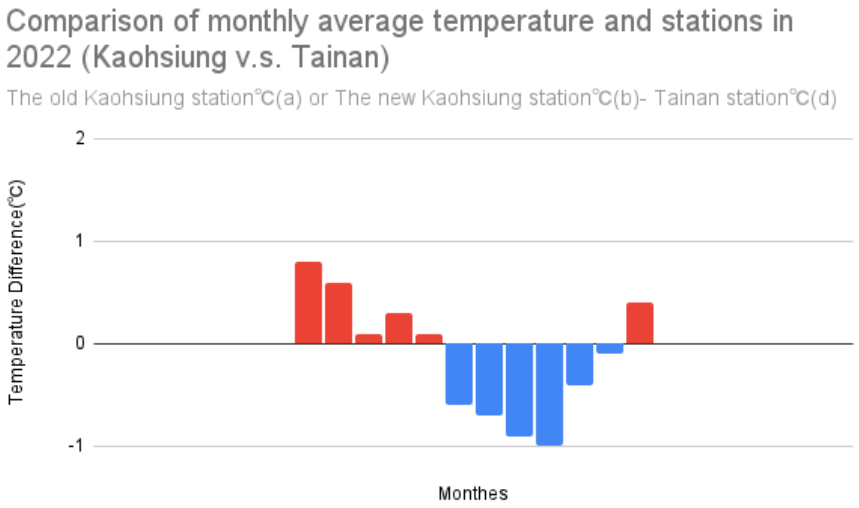


(Figure 9.Comparison of monthly average temperature in 2021)

Comparison of monthly average temperature and stations in 2022

2022 The average temperature	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
The old Kaohsiung station℃(a)	20.1	18.0	23.1	24.9	25.9							
The new Kaohsiung station℃(b)						28.6	29.2	28.5	27.7	26.1	25.0	19.0
Yongkang station℃(c)	18.5	17.4	22.8	24.6	25.7	29.3	29.9	29.1	28.5	26.3	25.0	18.6
Tainan station℃(d)	19.3	17.4	23.0	24.6	25.8	29.2	29.9	29.4	28.7	26.5	25.1	18.6
a-c	+1.6	+0.6	+0.3	+0.3	+0.2							
b-c						-0.7	-0.7	-0.6	-0.8	-0.2	0	+0.4
a-d	+0.8	+0.6	+0.1	+0.3	+0.1							
b-d						-0.6	-0.7	-0.9	-1.0	-0.4	-0.1	+0.4





(Figure 10.Comparison of monthly average temperature in 2022)

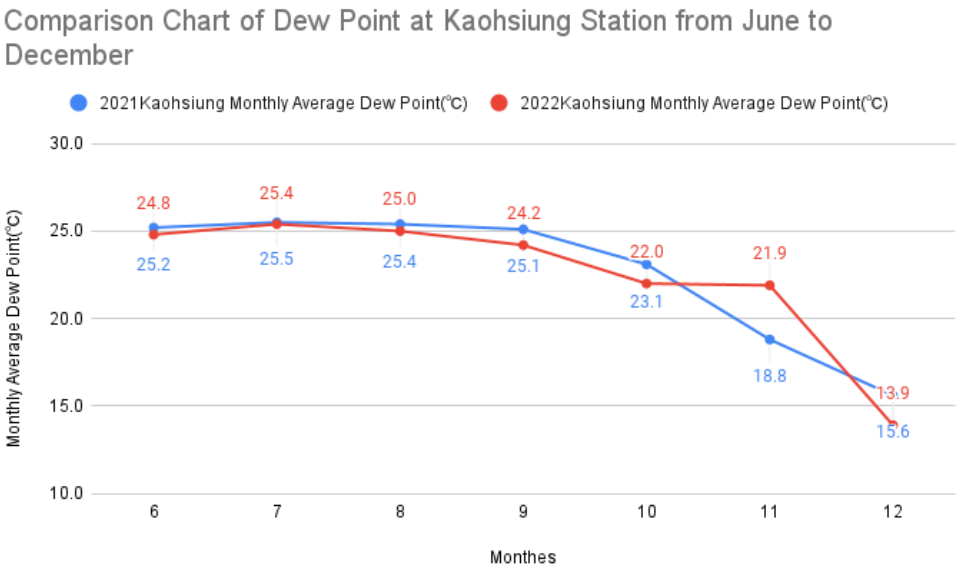
In the above tables, we use Tainan and Yongkang stations in Tainan City as baselines to compare the different temperature differences before and after the station relocation. As can be seen from Figure 9, the temperature of the former Kaohsiung station located in Qianzhen is higher than that of Tainan and Yongkang stations almost all year round. And also conforms to the rule that the lower the latitude, the higher the temperature. Only before and after summer, the temperature is slightly lower than that of Tainan and Yongkang stations, and the difference is not large. Figure 10 shows the data of Kaohsiung Station in Qianzhen from January to May, which continues this trend. Moreover, the temperature in Kaohsiung is continuously higher than that in Tainan and Yongkang stations, which shows that this trend is long-term.

However, after the station was moved in June 2022, the new station located in Nanzi was significantly lower than Tainan and Yongkang stations for a long time.

In addition, we found that in 2021, Kaohsiung Station did not have a higher month than Tainan (from May to September). It is also lower than Tainan. It can be generally known that the average monthly temperature in Tainan in summer will be higher than that in Kaohsiung. As for the detailed reasons, follow-up study is needed.

4.Discussion of the dew point

Dew point refers to the temperature at which the gaseous water contained in the air reaches saturation and condenses into liquid water under a fixed air pressure. The higher the dew point, the higher the absolute humidity (water pressure or water vapor volume) in the air, that is, the wetter air. We speculate that the old station in Qianzhen (467440) near the water before relocation should have a higher dew point.



(Figure 11.Comparison Chart of Dew Point at Kaohsiung Station from June to December in 2021 and 2022)

In Figure 11, we compared the dew point of the same month in different years. 2021 (blue curve) represents the old station of Qianzhen (467440) and 2022 (red curve) represents the new station of Nanzi (467441). Due to the new station was enabled from June 2022, so we only use the data from June to December. It can be seen from the figure that except for November, the blue curve is higher than the red curve, which conforms to the assumption that the humidity in the air at the old station is higher than the new one.

Comparison of monthly average dew point in 2022

2022 The average dew point	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
The old Kaohsiung station℃ (a)	15.4	15.0	18.8	20.0	23.0							
The new Kaohsiung station℃ (b)						24.8	25.4	25.0	24.2	22.0	21.9	13.9
Yongkang station℃ (c)	14.9	14.6	18.3	19.5	22.5	24.2	25.0	24.7	23.5	21.3	21.7	13.4
Tainan station℃ (d)	15.0	14.4	18.1	19.4	22.4	24.3	24.9	24.5	23.2	20.8	21.4	12.8
a-c	+0.5	+0.4	+0.5	+0.5	+0.5							
b-c						+0.6	+0.4	+0.3	+0.7	+0.7	+0.2	+0.5
a-d	+0.4	+0.6	+0.7	+0.6	+0.6							
b-d						+0.5	+0.5	+0.5	+1.0	+1.2	+0.5	+1.1

Comparison of monthly average dew point in 2021

2021 The average dew point	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
The old Kaohsiung station℃ (a)	12.5	15.4	18.5	20.4	24.4	25.2	25.5	25.4	25.1	23.1	18.8	15.6
Yongkang station℃ (c)	11.6	14.7	17.5	19.3	23.4	24.7	25.3	24.9	24.6	22.1	18.0	14.7
Tainan station℃ (d)	11.4	14.5	17.3	19.3	23.7	24.7	25.1	24.8	24.5	21.9	17.8	14.4
a-c	+0.9	+0.7	+1.0	+1.1	+1.0	+0.5	+0.2	+0.5	+0.5	+1.0	+0.8	+0.9
a-d	+1.1	+0.9	+1.2	+1.1	+0.7	+0.5	+0.4	+0.6	+0.6	+1.2	+1.0	+1.2

(Figure 12.Comparison of monthly average dew point in 2021 and 2022)

However, in order to eliminate the influence of other weather factors (such as fronts, typhoons, drought, etc.) that may occur suddenly in 2021 and 2022, we use the same analysis method as temperature to compare the dew point difference between stations. The conclusions are as follows:

1. The dew point values of the new and former stations in Kaohsiung are about 0.2℃-1.2℃ higher than those of Tainan and Yongkang stations each month.
2. The dew point difference between the new Kaohsiung station and Tainan and Yongkang stations from October to December (autumn to early winter) is slightly lower than that of the former Kaohsiung station. This is not quite the same as the original assumption that the new Kaohsiung station may be farther away from the sea after changing its position, which may lead to less actual water and gas in the air. It is worth analyzing after accumulating data in more different months.

Conclusion

By drawing line charts and bar charts of different comparison items, our conclusion on temperature is as follows: Because the adjacent sea is regulated by sea waters and the altitude is lower, the temperature measured at Qianzhen former station (467440) is higher than that at Nanzih new station(467441). In addition, in terms of dew point, the old station is also vulnerable to sea breeze at the seaside, resulting in higher dew point.

Since the new station only has the data in the second half of 2022, it is seriously insufficient, and we cannot calculate the specific value from the long-term data. Moreover, the results showed that each year was affected by different weather factors, so it was necessary to take a long-term average of the follow-up records to verify our findings.

Review of Literature

1. Inquiry of station code and station condition information - Central Weather Bureau.
   https://e-service.cwb.gov.tw/wdps/obs/state.ht

2. Data Bank for Atmospheric & Hydrologic Research
   https://dbar.pccu.edu.tw/Default.aspx

3. Wikipedia—Kaohsiung Weather Station
   https://zh.wikipedia.org/zh-tw/%E9%AB%98%E9%9B%84%E6%B0%A3%E8%B1%A1%E7%AB%99