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THE IMPACT OF CLIMATE CHANGE ON VISITOR ATTENDANCE AT LEISURE FARMS: EXAMINING THE ROLE OF RESTLESSNESS TRIGGERED BY TEMPERATURE CHANGES

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ABSTRACT

Climate change and global warming have become global issues, supported by evidence derived from multiple complex and independent climate indicators, including rising global average temperatures, ocean warming, sea-level rise, shrinking icebergs, and increased atmospheric moisture content. This study uses visitor numbers to Tsou-Ma-Lai Farm, as recorded by the Tourism Bureau of the Ministry of Transportation and Communications from 2014 to 2023, as the dependent variable. As independent variables representing climate change, meteorological data from Tainan City (2014–2023) were used, including monthly temperature, humidity, wind speed, rainfall, number of precipitation days, area pressure and sunshine duration. An Ordinary Least Squares (OLS) regression analysis was conducted to examine their effects. The results indicate that most independent variables did not significantly influence the dependent variable. However, after refining the model to retain the key variables, it was found that temperature had a significant negative impact on visitor numbers to the leisure farm. Specifically, for every unit increase in temperature, the number of visitors decreased by 1,362. Therefore, this study suggests not only emphasizing the global environmental effects of climate change but also addressing the negative impact of rising temperatures on the tourism industry.

Keywords: Climate Change, Restlessness, Ordinary Least Squares (OLS), Tourism Motivation, Tsou-Ma-Lai Farm

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1. INTRODUCTION

In recent years, climate change, extreme weather events, and global warming have emerged as critical environmental issues, posing significant threats worldwide. In 2023, the global average temperature reached an unprecedented record, increasing by 1.4°C, nearly exhausting the 1.5°C buffer zone set to mitigate climate impacts. Concurrently, the concentration of greenhouse gases in the atmosphere hit historic highs and continues to rise rapidly. The final agreement of the 28th session of the Conference of the Parties (COP28) aligns with the framework established in the 2015 Paris Agreement, aiming to limit the global temperature rise to within 1.5°C above pre-industrial levels to avert severe climate change impacts.

The influence of climate change on tourism activities manifests primarily in fluctuations in tourism demand, changes in travel patterns, and the selection of destinations (Li Jianlin, 2013). This is particularly evident in leisure farms, which depend heavily on natural environments and outdoor activities, and face heightened challenges due to climate variations (Fang Weida, 2023). High temperatures and the resultant discomfort caused by restlessness pose significant challenges to tourist visitation, making climate an essential consideration in tourism planning (Wang Maomao, 2022). The calculation of the Tourism Climate Index (TCI) has been widely recognized as a systematic method to evaluate the impact of climate on tourism experience quality (Mieczkowski, 1985).

Previous studies have predominantly focused on exploring the influence of climate change on tourism motivation, with limited attention given to the analysis from the perspective of external physiological characteristics stimulating psychological reactions, such as the generation of restlessness. Tsou-Ma-Lai Farm, a renowned leisure and ecological tourism destination in Tainan City, attracts a large number of visitors with its unique agricultural landscapes and diverse outdoor experiential activities.

This study investigates the relationship between climate variability—specifically changes in temperature, humidity, and wind speed—and tourist arrivals at Tsou-Ma-Lai Farm from 2014 to 2023. It examines whether the discomfort caused by climate change affects tourists' motivation to visit agritourism destinations. In addition to analyzing the trends in tourist arrivals at Tsou-Ma-Lai Farm over the past decade, the study explores the correlation between restlessness due to climate change and tourist visitation. This analysis aims to provide insights into the broader implications of climate change for the tourism industry.

2. LITERATURE REVIEW AND CASE INTRODUCTION

2.1 The Impact of Climatic Factors on Tourism Behavior

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The World Tourism Organization (WTO) highlights the significant influence of climate conditions on tourism behavior. According to Xia Bingfeng (2013), weather and climate are among the key determinants in travelers' decisions to embark on trips. Cai Guosheng (2023) notes that favorable climatic conditions, such as suitable temperatures and clear skies, promote tourism activities, while extreme weather events like heatwaves, heavy rainfall, and typhoons suppress tourism demand. Anwar Sadat Shimul (2024) emphasizes that consumers are becoming increasingly aware of the urgent and complex challenges associated with climate change, with greater environmental knowledge contributing to shared national evaluations. Bigano et al. (2006) observe that tourists prefer destinations with sunny and mild climates, avoiding excessively hot or cold conditions. Amelung et al. (2007) combined two climate change scenarios with the Tourism Climate Index (TCI), suggesting that under projected climate changes, ideal tourism conditions may shift toward polar regions. Scott et al. (2004) point out that global climate change has the potential to alter the distribution of climate assets across tourism destinations, influencing seasonality, demand, and travel patterns. As such, climate assessment has become a critical consideration for tourism.

2.2 The Impact of Climate Variables on Visitor Numbers to Leisure Farms

When planning trips, travelers often prioritize seasonal and weather variations when selecting destinations. Li Jianlin (2013) identified that temperature significantly influences leisure agricultural tourism. Moderate temperatures attract more visitors, while extreme highs or lows reduce tourist numbers. Liu Guo'an et al. (2013) suggest that although humidity has a relatively minor impact on tourism, high humidity increases discomfort, thereby affecting the quality of the experience and visitor turnout. Studies show that excessive humidity leads tourists to prefer indoor activities or cancel travel plans. Goh (2012) found that climate factors such as temperature, precipitation, and humidity significantly affect travel patterns. Li Jianlin (2013) further highlights that increases in temperature, rainfall, and wind speed decrease tourist numbers, whereas longer sunshine hours encourage outdoor travel. Loomis and Crespi (1999) observe that higher temperatures or increased rainfall alter tourism environments by causing large-scale changes in the quality and quantity of natural resources affected by climate change. As discussed, temperature is a fundamental determinant for travel, with tourists factoring climate conditions into their decisions.

2.3 The Influence of Climate on Tourism Motivation

Tourism motivation stems from various factors. Dann (1977) proposes that tourism motivation arises from a psychological need to escape—individuals seek to break away from monotonous routines and familiar surroundings. McIntosh et al. (1995) categorized tourism motivation into four types: (1) **Physiological incentives**, which alleviate tension and anxiety through physical activity, such as rest, exercise, and recreation; (2) **Cultural incentives**, driven by a desire to

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understand the customs, traditions, and history of specific regions; (3) **Interpersonal incentives**, involving socializing with new acquaintances or visiting friends and family; and (4) **Prestige and status incentives**, motivated by a need for recognition or attention from others. This study focuses on environmental factors as stimulants for psychological and physiological motivations, particularly how comfort, discomfort, and the sense of escape influence tourism behavior. Restlessness, an external physiological condition, acts as a trigger for psychological responses, demonstrating that climate significantly impacts tourism motivation.

2.4 The Impact of Extreme Weather Events

Tainan frequently experiences typhoons. Over the past decade, the region has endured multiple typhoons, such as Typhoon Soudelor in 2015, Typhoon Meranti in 2016, and the recent Typhoon Koinu in 2024. These events caused extensive damage, including an estimated NT$3.6 billion loss in agricultural products and public infrastructure, the evacuation of tens of thousands of residents, severe flooding in southern Taiwan, and landslides across multiple areas (Global Disaster Database). Such typhoons have inflicted considerable losses on the local tourism industry. Cai Guosheng (2023) highlights that extreme weather events, such as typhoons, lead to sharp declines in visitor numbers and damage to farm facilities and landscapes. Moises Neil V. Seriño (2021) discusses the challenges faced by small-scale coconut farmers in the Philippines following the devastation of Super Typhoon Haiyan. The destructive impacts of such storms have placed the livelihoods of millions who depend on coconut farming at significant risk. These examples underscore that natural disasters cause tourists to refrain from travel and prevent farms from operating due to damaged facilities.

2.5 Tsou-Ma-Lai Farm

Tsou-Ma-Lai Farm, operated by the Tainan Farmers' Association, is a prominent leisure farm that emerged during the early growth and exploration phases of leisure agriculture from 1980 to 1989. It is one of Taiwan's three most iconic leisure farms (Duan Zhaolin, 2007). Initially specializing in professional grass cultivation, the farm transitioned into a tourism and recreation destination. It was among the first to receive an official leisure farm license from the Ministry of Agriculture and was recognized as a certified scenic area. The farm has repeatedly earned excellence awards in evaluations.

Located at the intersection of Yujing and Danei in Tainan, Tsou-Ma-Lai Farm is conveniently accessible via the Tsou-Ma-Lai Interchange on Route 84, a major east-west expressway. Surrounded by the midstream section of the Zengwen River and embraced by the Alishan Mountain Range, the farm offers a serene haven with abundant tourism resources. Spanning 120 hectares, the farm features 40 hectares of New Zealand-style pastoral grasslands. Over the past three decades, it has developed dozens of recreational facilities, offering diverse services,

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including tourism, leisure activities, dining, lodging, camping, conferences, agricultural experiences, food and agricultural education, environmental education, and ecological tourism.

3. RESEARCH METHODOLOGY

3.1 Data

To conduct the empirical analysis, this study utilizes monthly visitor data for Tsou-Ma-Lai Farm in Tainan City from 2014 to 2023, retrieved from the Tourism Bureau's statistical database on tourism and recreation sites. The independent variables include monthly climatic data for Tainan City from 2014 to 2023, obtained from the Central Weather Bureau. These variables consist of temperature, humidity, wind speed, rainfall, atmospheric pressure, number of precipitation days, and sunshine hours, which serve as the basis for statistical analysis.

3.2 Research Methodology

This study examines the impact of climate-induced discomfort on visitor motivation and the number of visitors to Tsou-Ma-Lai Farm. The Ordinary Least Squares (OLS) method, also known as simple regression analysis, is employed as the theoretical framework for the research model. The estimated OLS model equation is as follows:

$$visitors=\alpha+\beta1 \cdot temperature+\beta2 \cdot humidity+\beta3 \cdot windspeed+\beta4 \cdot rainfall+\beta5\ number\ of\ precipitation\ days+\beta6 \cdot area\ pressure+\beta7 \cdot sunshine\ hours+\epsilon \quad (1)$$

The model represents the relationship between visitor numbers (visitors) and climatic factors, including temperature (temperature), humidity (humidity), wind speed (windspeed), rainfall (rainfall), atmospheric pressure (area pressure), number of precipitation days (number of precipitation days), and sunshine hours (sunshine hours).

- α represents the intercept term (constant), which predicts the number of visitors when all independent variables (temperature, humidity, wind speed, rainfall, atmospheric pressure, number of precipitation days, and sunshine hours) are zero.
- β_1 represents the regression coefficient for temperature, indicating the effect on visitor numbers for each unit change in temperature.
- β_2 represents the regression coefficient for humidity, indicating the effect on visitor numbers for each unit change in humidity.
- β_3 represents the regression coefficient for wind speed, indicating the effect on visitor numbers for each unit increase in wind speed.
- β_4 represents the regression coefficient for rainfall, indicating the effect on visitor numbers for each unit change in rainfall.
- β_5 represents the regression coefficient for atmospheric pressure, indicating the effect on

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visitor numbers for each unit change in atmospheric pressure.

- β_6 represents the regression coefficient for the number of precipitation days, indicating the effect on visitor numbers for each additional precipitation day.
- β_7 represents the regression coefficient for sunshine hours, indicating the effect on visitor numbers for each additional sunshine hour.
- ϵ represents the error term, capturing the effects of all factors not included in the model.

4. RESULTS AND ANALYSIS

4.1 Descriptive Statistical Analysis

Tsou-Ma-Lai Farm, located within the Siraya National Scenic Area, was originally a settlement of the Siraya indigenous people over 400 years ago. Since 1988, it has been developed and operated by the Tainan Farmers' Association as Taiwan's first leisure agriculture-themed amusement park. The farm offers diverse attractions, including natural landscapes, agricultural experiences, ecological tours, over 150 species of wildlife, lodging, weekend performances, and more, making it a year-round, 365-day leisure destination. Tsou-Ma-Lai Farm actively integrates agricultural experiences with food education concepts, combining high-quality agricultural practices with lifestyle habits. Through a series of activities, the farm promotes sustainable living in aspects such as "food education," "local economy," and "environmental ecology."

In the preliminary phase of this study, a decade's worth of data was analyzed by categorizing travel patterns according to the four seasons—spring, summer, autumn, and winter. However, the analysis revealed no statistically significant seasonal variation. Consequently, the study proceeded with the use of annual average data for further analysis.

- **Visitor Numbers:** Observations range from 13,039 to 46,362, with an average of 23,825 visitors and a standard deviation of 8,552.542, indicating the variability in visitor numbers.
- **Temperature:** Observations range from 18.19°C to 29.64°C, with an average of 24.95°C and a standard deviation of 4.2867, reflecting the variation in temperatures.
- **Humidity:** Observations range from 72% to 79%, with an average of 74.75% and a standard deviation of 2.050499, showing the degree of humidity fluctuation.
- **Wind Speed:** Observations range from 8.25 m/s to 11.56 m/s, with an average of 9.55 m/s and a standard deviation of 0.9542728 m/s, demonstrating wind speed variability.
- **Rainfall:** Observations range from 11.6 mm to 574.3 mm, with an average of 144.8 mm and a standard deviation of 178.1187 mm, indicating significant rainfall variability.
- **Number of Precipitation Days:** Observations range from 1.5 days to 16.8 days, with an average of 6.95 days and a standard deviation of 5.341859, showing variability in precipitation frequency.

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- **Atmospheric Pressure:** Observations range from 1004.46 hPa to 1015.98 hPa, with an average of 1009.953 hPa and a standard deviation of 4.699673, reflecting pressure variations.
- **Sunshine Hours:** Observations range from 171.65 hours to 217.21 hours, with an average of 198.2317 hours and a standard deviation of 14.820026, indicating the variability in sunshine duration.

These statistical insights provide a foundational understanding of the variations in climate factors and visitor numbers, setting the stage for further analysis of their relationships and influences.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Visitors	12	23825.08	8552.542	13039	46362
Temperature	12	24.95	4.2867	18.19	29.64
Humidity	12	74.75	2.050499	72	79
WindSpeed	12	9.55	0.9542728	8.25	11.56
Rainfall	12	144.8	178.1187	11.6	574.3
Precipitation days	12	6.95	5.341859	1.5	16.8
Atmospheric.Pressure	12	1009.953	4.699673	1003.46	1015.98
Sunshine Hours	12	198.2317	14.820026	171.65	217.21

Source: This study

4.2 Empirical Results

Table 2: Full Model Analysis

The results of the full model analysis indicate that temperature does not significantly affect the number of visitors to Tsou-Ma-Lai Farm, with a p-value of 0.329, which is greater than the 5% significance threshold ($p > 0.05$). Similarly, humidity ($p = 0.721$), wind speed ($p > 0.05$), rainfall ($p = 0.299$), number of precipitation days ($p = 0.765$), atmospheric pressure ($p = 0.343$), and sunshine hours ($p = 0.468$) all exhibit p-values exceeding 0.05, suggesting no significant impact of these variables on visitor numbers.

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Table 2: Research Results

Visitors	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Temperature	-8272.033	7454.183	-1.11	0.329	-28968.16	12424.1
Humidity	1660.987	4337.058	0.38	0.721	-10380.62	13702.59
WindSpeed	-3100.624	4522.54	-0.69	0.531	-15657.21	9455.959
Rainfall	-115.7878	96.98761	-1.19	0.299	-385.0686	153.493
Precipitation days	-1230.788	3849.702	-0.32	0.765	-11919.27	9457.698
Atmospheric Pressure	-11209.48	10435.06	-1.07	0.343	-40181.85	17762.88
Sunshine Hours	-342.0619	427.0854	-0.8	0.468	-1527.841	843.7173
_cons	1.15e+07	1.07e+07	1.08	0.339	-1.80e+07	4.11e+07

Source: This study

Table 3: Refined Model with Key Variables

After refining the model to retain the three most critical variables, the results reveal the following:

- **Temperature** shows a significant impact on visitor numbers, with a p-value of 0.028, which is below the 5% significance threshold ($p < 0.05$). This indicates that temperature has a statistically significant effect on the number of visitors to Tsou-Ma-Lai Farm. Specifically, for every unit increase in temperature, the number of visitors decreases by an average of approximately 1,362.
- **Humidity** has a p-value of 0.930, which exceeds the 5% significance threshold ($p > 0.05$), indicating no significant impact on visitor numbers.
- **Wind Speed** also has a p-value of 0.466, which is greater than 0.05, suggesting no significant influence on visitor numbers.

Summary of Key Findings

- Temperature is the only variable found to have a statistically significant impact on visitor numbers when the model is refined, with higher temperatures leading to a reduction in visitor turnout.
- Other climatic variables, including humidity, wind speed, rainfall, number of precipitation days, atmospheric pressure, and sunshine hours, do not show significant effects on visitor numbers in either the full or refined models.

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Table 3: Research Results

Visitors	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Temperature	-1362.436	507.8951	-2.68	*0.028	2553.561	191.3109
Humidity	94.37472	1044.172	0.09	0.930	-2313.489	2502.239
WindSpeed	-1702.826	2227.074	-0.76	0.466	-6838.467	3432.815
_cons	67025.34	73386.24	0.91	0.388	-102203.6	236254.3

Note: Statistical significance is indicated at the 5% level (*p < 0.05).
Source: This study.

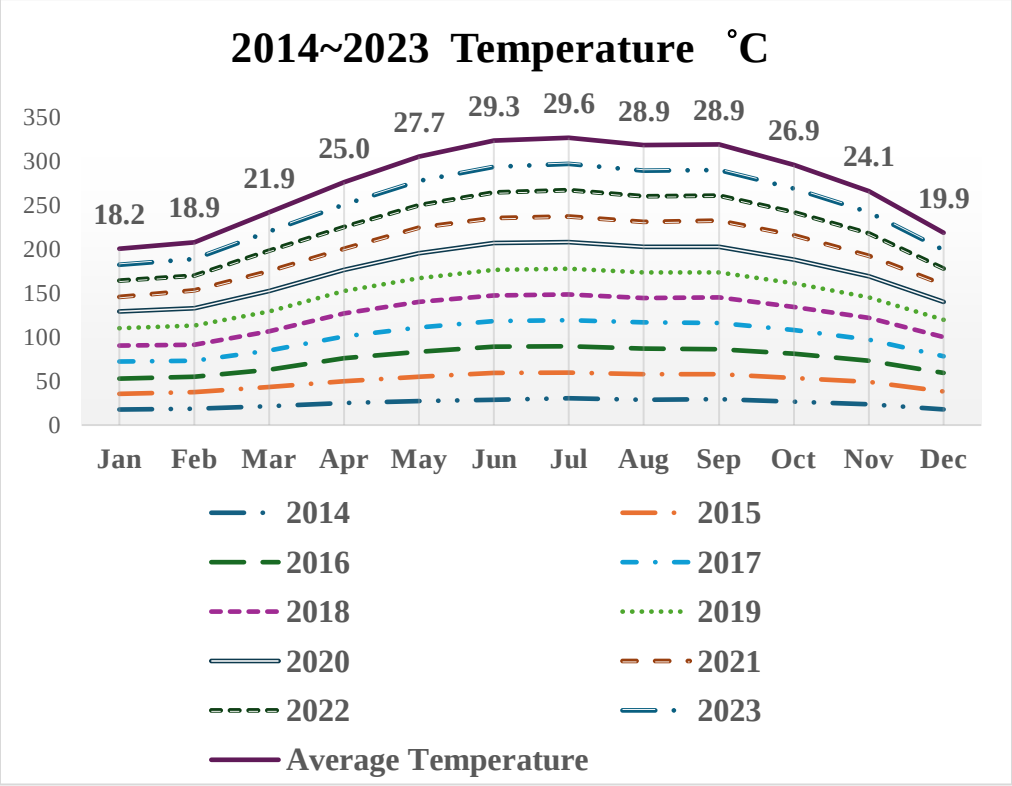

Figure 1: Monthly Average Temperatures in Tainan City Over the Past 10 Years

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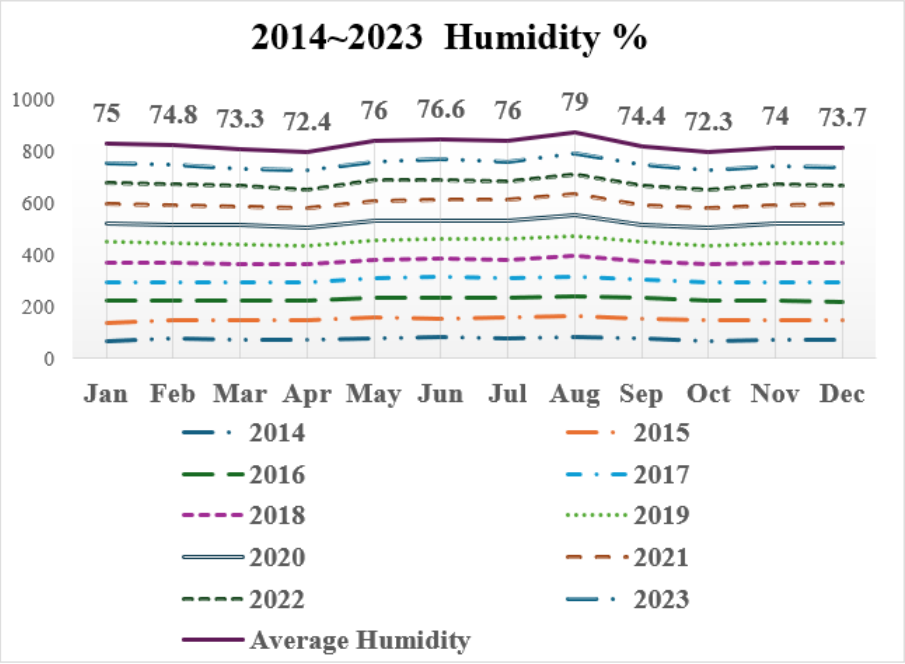

Figure 2: Monthly Average Humidity in Tainan City Over the Past 10 Years

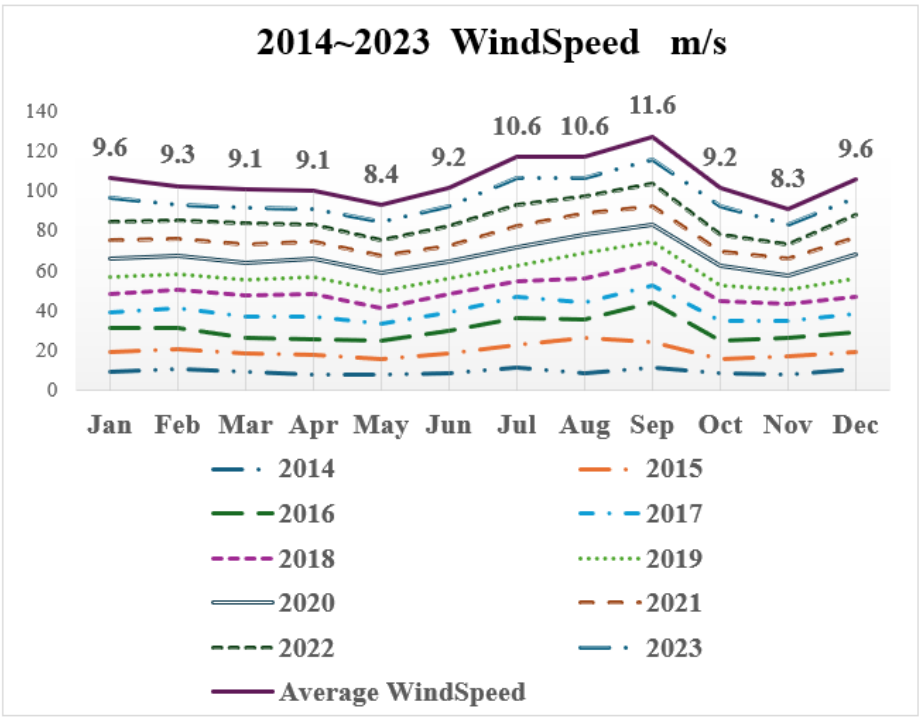

Figure 3: Monthly Average Wind Speed in Tainan City Over the Past 10 Years

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5. CONCLUSION AND RESEARCH LIMITATIONS

5.1 Conclusion

Tsou-Ma-Lai Farm integrates tourism, recreation, sightseeing, dining, lodging, camping, conferences, agricultural experiences, food and agricultural education, environmental education, and eco-tourism, making it a top destination for travelers in Taiwan. The empirical results of this study indicate that temperature significantly affects visitor numbers, as the discomfort caused by higher temperatures impacts the willingness to travel. However, humidity and wind speed were found to have no direct effect on visitor numbers or travel intentions.

Climatic factors influence both psychological and physiological motivations, as comfort, discomfort, and the sense of escape serve as stimulants for travel behavior. Discomfort, as an external physiological reaction, triggers psychological responses. An intriguing finding is that higher humidity intensifies discomfort, as perceived temperature increases with elevated humidity levels. This can lead to heat-related conditions such as heat exhaustion, heatstroke, and fainting.

It is recommended that Tsou-Ma-Lai Farm implement measures to mitigate the effects of high temperatures. Suggestions include increasing shaded areas, setting up portable shade structures such as tents or umbrellas in non-fixed activity zones, and using fine water mist systems to lower ambient temperatures. These measures could help alleviate discomfort caused by adverse climatic conditions.

5.2 Research Limitations

This study focuses on Tsou-Ma-Lai Farm in Tainan City, with data spanning the period from 2014 to 2023. Due to limitations in data availability, the analysis of discomfort factors primarily considers temperature, humidity, and wind speed as the main climatic variables. However, discomfort may also be influenced by other factors, such as mood or geomagnetic conditions, which were not included in this study. Therefore, the definition of discomfort in this research is not exhaustive.

The data used in this study specifically examine the relationship between local discomfort in Tainan and its impact on visitor numbers at Tsou-Ma-Lai Farm. It does not account for the discomfort tourists may experience prior to their departure. Due to these constraints, the definition of travel intentions and discomfort may not be entirely precise or comprehensive.

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