An Example of Ecological Wisdom in Historical Settlement: The Wind Environment of Huazhai Village in Taiwan

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Abstract

During the initial developmental stage of historical settlement, residents used the principles of *feng shui* to locate suitable residence sites to ensure quality of life. Using Huazhai Village in Taiwan as a case study, this study explores the design philosophy of ancient Chinese people through scientific analysis. Research showed that the region was characterized by a windy climate. Therefore, a computational fluid dynamics model was used to simulate the local wind environment and restore the early architectural complex of the village. Compared to the current situation, it was demonstrated that the planning principles of the early buildings gave first priority to site selection. Second, with the village streets acting as a wind corridor, the angle of the streets was well utilized to strengthen outdoor ventilation in summer. Third, according to wind field characteristics at different locations, various opening directions and arrangement modes were applied in different areas to improve the wind field of the living environment. This ancient ecological wisdom provides current designers with a new strategy for living in harmony with nature, which may aid the design of sustainable living environments that adapt to the climate.

Keywords: Wind environment; Sustainable design; CFD; Historical settlement; Taiwan

1. Introduction

Learning culture and technology from ancient legacies is one way to achieve the sustainable use and development of urban areas, landscapes, and regions. Ancient ecological wisdom can furnish guidelines for current sustainable development planning (Xiang, 2014). *Feng shui* is an environmental evaluation system handed down by ancient Chinese people through their accumulated life experience. It includes analysis of the natural environment and of location and direction. The location, direction, height, and other characteristics of buildings were arranged according to the character of the natural environment (Needham, 1971), thus representing the ecological wisdom of ancient people in residential and village planning.

During the early development stage of an historical settlement, residents usually searched for a suitable living environment and constructed a group of buildings together to ensure quality of life. This process is closely related to the traditional Chinese *feng shui* knowledge, and is called site selection (Yi *et al.*, 1996).

Over the past 50 years, computational fluid dynamics (CFD) has been developed as a powerful tool for wind field evaluation (Blocken *et al.*, 2015). Compared to wind tunnel experiments, CFD can better render the complex flow field phenomena. CFD has been used to assist building and urban design in England, Japan, and the USA (Tang *et al.*, 2012). It can provide designers with accurate parameters and help them to plan urban and residential areas scientifically, which can reduce the impact of new designs on the surrounding environment and the use of energy in the future (e.g., Yuan and Ng, 2013; Hsieh *et al.*, 2011). The pedestrian-level wind field is an important research focus of CFD-related research. This is the wind field around buildings at a height of 1.5–2 m above ground, which affects the comfort of walking and standing pedestrians. Building configuration (e.g., height, width, arrangement, and density) has been shown to have a strong influence on wind at the ground level (Mochida & Lun, 2008; Shia *et al.*, 2015). Wind speed affects pedestrian comfort and wind safety. (Blocken *et al.*, 2012). Many countries have already established evaluation criteria and minimum tolerable wind speed value ranges (Mochida & Lun, 2008). Research into wind comfort and safety of a pedestrian-level wind field in Taiwan showed that when gender and activity differences were not considered, the maximum wind

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speed for pedestrian comfort was around 6–7 m/s (Guo *et al.*, 2011). In residential and wind damage-sensitive areas in Taiwan, the maximum wind speed for wind comfort is 8 m/s (Ding & Chu, 2000). In 2005, commissioned by the Hong Kong government, the Chinese University of Hong Kong conducted air ventilation assessment research, stipulating outdoor air ventilation regulations in 2006. Research showed that increasing outdoor wind speeds in summer could raise outdoor comfort levels. On a typical summer day, when the air temperature is 27.9°C and the relative humidity is 80%, a wind speed between 0.6 and 1.3 m/s is required to achieve neutral thermal sensation (Yuan & Ng, 2011). These results were used as evidence to evaluate the wind field of the historical community in this study.

A review of the published literature shows that CFD simulation research into historical building complexes and historical communities remains sparse. Only Tang *et al.* (2012, 2014) simulated a Chinese historical community using a simple current 3D terrain model, and investigated the influence of terrain on historical settlement in two separate chapters, i.e., the CFD wind environment and thermal environment. In their research, only the current status was simulated, with no simulation of the past for the historical community. The authors did not precisely simulate the group of buildings inside the community and surrounding environment, nor did they address the arrangement and planning of the building complex or the relationship of the buildings to the environment.

The majority of historical settlements used the principles of *feng shui* to identify suitable residence sites. Since most *feng shui* knowledge is based on intuition, it is not possible to elucidate the impact of *feng shui* on historical settlements. This study attempts to use existing science and technology to analyze whether a settlement, which was selected based on the principles of *feng shui*, has a good living environment. In addition, this study aims to understand the planning strategies residents used to create a comfortable living environment that adapts to the local climate, and to verify the ecological wisdom of ancient Chinese people in creating a sustainable living environment, in order to provide a reference for current planners.

2. Study Area

Huazhai Village (23°22'17.4"N 119°29'45.8"E) is on Wangan Island in Penghu County. Huazhai is the old name of the area, which is now called Jungshe Village. The village was established about 300 years ago, comprising a total area of 5,900 m^2. The total number of buildings is 160, of which over 139 are historical and 19 are modern. The residents engage in both farming and fishing. Due to changes in fishing technology and a scarcity of coastal ocean resources, the residents have begun to emigrate in recent years.

The village faces the Taiwan Strait on the west. As shown in Fig.2., the village is surrounded by five hills that are 3–25 m above ground level (AGL) in a flower-petal shape, which gives it the name Huazhai; a Chinese word meaning flower. The two hills on the north are the highest (spots A and B), followed by the one on the northeast (spot C). Hill A is 40 m above sea level (ASL), Hill B is 35 m ASL, Hill C is 25 m ASL, Hill D is 22.5 m ASL, and Hill E is 24.3 m ASL (Fig.2.). There is a raised mound of 8 m ASL in the center of the community called Hua-si (spot F), a Chinese word for the center of a flower. This mound is considered holy by residents, and no planting or grazing is allowed there.

According to traditional Chinese *feng shui* knowledge, a good location must be able to gather *chi*, and intersect and balance yin and yang (Han, 1995; Xu, 1990). This location should be in front of a mountain (representing yin) and behind water (representing yang). Layers of mountains and water surrounding the area form a space of yin and yang intersection, which is called *Ming Tang*. The center of *Ming Tang* is *Hsueh*, which is the best location with the most abundant vital energy or *chi* (Fig.1.). The basic principle of site selection was illustrated in ancient books including Canon of Virtue of the Tao, the Book of Master Kuan and Book of Odes. There are also old sayings such as "*chi* exists where surrounded by mountains and water," "ward off yin while embracing yang," and "backed by hills while facing watercourses". All of this indicates that locations with these characteristics are protected from winds to maintain vital energy, i.e., those locations can embrace the wind and maintain *chi*. These locations were thus suitable for residence.

We chose to analyze the Huazhai Village based on the above discussion of a good location based on *feng shui* knowledge. Five hills surround the village on one side, the sea is at the front of the village, and there are a few islands in the sea. These are known as Face Mountain (*Chao Shan*) and Table Mountain (*An Shan*). Therefore, the *Hsueh* of the village is Hua-si; the raised mound in the center of the village. The characteristics of this settlement are consistent with the basic principles of site selection in *feng shui* and with the configuration of Fig.1., which shows that the site of the settlement was selected based on the principles of *feng shui.*

Thus, the study area was chosen in accordance with this concept, using Hua-si as the center and extending outward by 400 m. Hua-si is close to the center of the village, and the study area covered all village buildings and the surrounding hills.

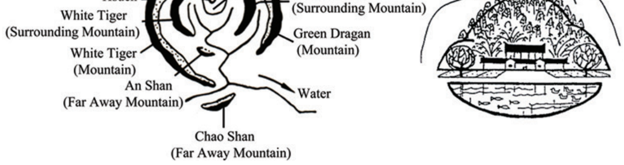


Fig.1. An Excellent Location as Defined by *feng shui* (Mak, M. Y., & Thomas Ng, S., 2005; Yi *et al.*, 1996)

Fig.2. Dotted Square Shows the Study Area; A–E Represent the Locations of Hills Surrounding Huazhai Village

3. Methodology

3.1 Use of Meteorological Data

In order to simulate the long-term wind environment, this study used long-term meteorological data of the local area. There are two meteorological stations nearby. The station built in 1896 has relatively complete data, but is comparatively far from Huazhai Village. To avoid errors in wind speed and direction, data collected by the Wangan Aviation Meteorological Station, about 700 m from Huazhai Village on its east side, were used to analyze weather conditions. The anemometer height is 10 m AGL, with an altitude of 42.9 m ASL. Analysis of meteorological data from the station over the past 15 years indicates that summer in the area is from June through September, with average wind speeds of 4.86 m/s and a predominant wind direction of south-southwest. Winter is from November through March, with average wind speeds of 9.59 m/s and a predominant wind direction of north-northeast. The mean maximum wind speed can reach 24.6 m/s. These data were used for the simulation settings.

3.2 CFD Model

3.2.1 Modeling of the Current Community

To accurately simulate the current wind field, we used a Photon 80 3D laser scanner manufactured by FARO Technologies US Ltd., Warwickshire US. Colored laser scanning from the ground or air was used to obtain data of the village buildings and fine point-cloud data of the ground surface topography. The point cloud data were then used to build an accurate 3D model of the current community, which included its buildings and the surrounding terrain. The 3D model was converted by the 3D mapping software to STL (the standard 45210 file type most extensively applied by the rapid prototyping system) and imported to CFD for simulation. The modeling process was as follows. 1) Ground scanning was performed along the streets using the 3D laser scanner, followed by airborne scanning using the scanner aboard an aircraft. The point cloud data obtained from the ground and flight were combined. 2) We used point-cloud modeling software, the Pointools plug-in for Sktchup, developed by Pointools Co. (England). Point-cloud data were imported into Sktchup directly, and the 3D model of the buildings was constructed directly on the point cloud. As the sloping roofs of the buildings may affect the simulation results, those parts were depicted in detail. 3). Cleanedge software was used to assist construction of the 3D terrain model. A complete model of the current community was built based on 3D modelling of buildings and terrain.

3.2.2 Restoration Modeling of Early Settlement

While we cannot go back to the past to observe the initial site selection process, we can try to find the earliest possible information, build a model representing the building location and type of the early settlement, and analyze the reasons for choosing the area for residence and the impact of building location and direction on the village wind field. Current aerial photogrammetry was compared with several old maps, including the Taiwan topographic map sketched by the Japanese Imperial Army Land Survey in 1895 (scale: 1/50,000), 1926 Taiwan topographic map, 1960 Taiwan topographic map economic planning edition (scale: 1/25,000), and 1980 aerial photogrammetry (scale: 1/5,000). These maps indicated that the landscape of Huazhai Village has changed very little. Thus, the 3D model was constructed using current 3D geomorphology of the community and ancient buildings restored according to extant earliest historical data. The data file was then converted to STL and imported to CFD for simulation.

To restore the buildings of the early settlement, we used a 1904 Taiwan map (scale: 1/20,000), blueprint cadastral maps of the government from 1913 to 1991, and land accounting books from 1898 to 1945. The accounting books recorded changes in land ownership, land splitting, merging and sales: information that was critical for the building restoration. From community historical data, the earliest time we were able to restore was 1913. This represented the state of the village during the Qing Dynasty, which was close to the initial formation state of the settlement. The restoration process was as follows.

1. Restoration of building locations and roads. The locations and numbers of buildings were restored according to old building sites and road land categories from the historical data. Roads and farmlands were found via land category and cadastral maps, and then marked on the restored cadastral map.

2. Restoration of the buildings. Firstly, the ages and sizes of the existing buildings were investigated and complex configuration figures were drawn for the buildings constructed around 1913. Statistics of the measurements of the remaining buildings were used to estimate the length, width and height of the buildings, which were not retained. Then, a 3D model was

constructed in accordance with the breadth and depth of the restored cadastral map.

3.3 CFD Simulation: Computational Settings and Parameters

The software used for CFD simulation was WindPerfect. The governing equations were solved using the structured finite-volume method of discretization. The effect of buoyancy was considered using the Boussinesq approximation. A second-order upwind scheme was used to interpolate values from cell centers to nodes for the convective terms. The convergence criterion for the wind was 10E-4.

The computational domain horizontal size was 800 m x 800 m, and its height was 300 m. The building assembly of Huazhai Village was the area of focus, with an extent of 350 m x 350 m. As the average street width in Huazhai Village is about 2.4 m, the horizontal grid resolution in the focus area was set to 1.2 m x 1.2 m. All buildings are one-story with a height of 3.5–4 m, so the vertical grid resolution in the focus area was 1 m. Grid density was gradually reduced from the focus area outwards, and the total grid number was 9,643,200.

There are altogether five hills surrounding Huazhai Village. Limited by the grid number, the simulation range could not cover all these hills. There are only four hills within the simulation domain, among which the highest two are north and northeast of the settlement, with an average height of 30 m ASL. The average height of the other hills is 23.4 m ASL. The study area has a flat terrain. When the wind encounters the terrain, it accelerates and there is a local speed-up effect within a medium and small-scale range. The wind speed was calculated according to Eq. (1).

$$K = \frac{V'_{(z)} - V_{(z)}}{V_{(z)}} \qquad (1)$$

$V_{(z)}$: Horizontal wind speed unaffected by terrain

$V'_{(z)}$: Wind speed affected by terrain

K: Speed-up coefficient caused by terrain

According to the wind power specification announced by the Taiwanese government (Construction and Planning Agency, 2014), K is referred to as the terrain coefficient, which represents the local speed-up effect on the upper half of an independent hill or ridge or atop a cliff. If the height H of this independent hill, ridge or cliff is over twice the height of the terrain within 3.22 km of the windward side, and is > 4.5 m (spot C) or 18 m (spot A or B), and this independent hill, ridge or cliff does not have any barriers of similar height within 100H or 3.22 km (the smaller value between the two is used) of the windward side, and H/L ≥ 0.2, then K can be calculated according to Equation (2). If the site conditions and locations of buildings and other structures do not meet all the conditions specified in Section 2, then K = 1. If the surrounding environment of the village does not fully meet all conditions specified for the use of Equation (2) and H/L_n < 0.2, then K = 1 and it is regarded as the parameter value for use in the simulation. Moreover, 42.9 m ASL, the anemometer altitude of the meteorological station east of Huazhai Village, was used as the reference height. Average wind speeds in winter and summer measured by the station were regarded as benchmark wind speeds to simulate the wind fields of Huazhai Village in those two seasons.

$$K = (1 + K_1 K_2 K_3)^2 \qquad (2)$$

K_1: Factor to account for shape of topographic features and maximum speed-up effect.

K_2: Factor to account for reduction in speed-up with distance upwind or downwind of a crest.

K_3: Factor to account for reduction in speed-up with height above local terrain.

The traditional buildings in Huazhai Village are one-story; with a height of 3.5–4 m. Newly constructed buildings are mostly three to four stories high. The area is subject to strong winds for about one third of the year. A strong northeast monsoon in winter affects the height of the plants grown in the area and causes high salt content in the soil. The landscape therefore mainly comprises grassland, shrubs, and low crops. The average elevation of the surrounding hills is 27.95 m ASL. According to the latest specifications published by the Taiwanese government, there are three definitions of land surface roughness, each with its own unique α. Land-surface roughness is divided into categories based on building location and proximate surface characteristics. The area of Huazhai Village belongs to the category of suburb, small town, or areas with houses 10–20 m in height, and with barriers higher than houses scattered in between. Thus, the land-surface roughness was set to 0.25. The simulation grid is shown in Fig.3. For the surrounding area, the mesh size became gradually coarser with distance from the center.

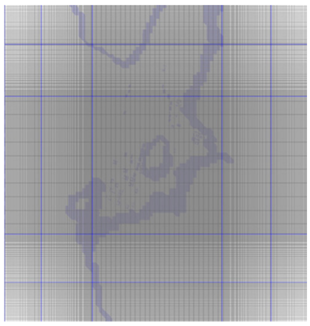
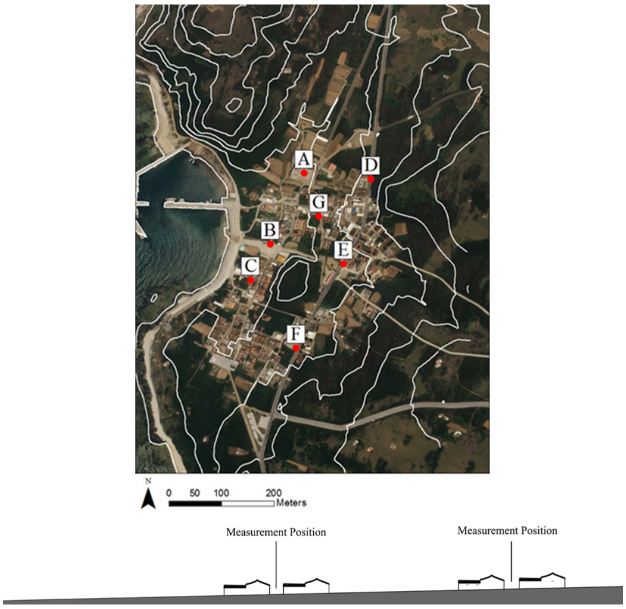


Fig.3. CFD Simulation Grid

4. Results and Discussion

4.1 CFD Validation by Outside Measurement

The west side of the village faces the sea, and is the lowest point in the area. The terrain gradually rises away from this side. Buildings were constructed along the gentle slope and formed two groups. Most of these buildings and the main street were centered within an area of elevation 2.3 m ASL, where the largest plaza of the village is situated. All other buildings and streets are in areas of elevation 6.3 m ASL. We made one-day measurements in the two building groups along the streets. The selected location (Fig.4.) may be the area with the smallest change in current buildings compared to the early settlement. The wind field at 1.5 m AGL was measured, data were collected every second, and seven measuring points were established.



(a) (b)

Fig.4. (a) Locations of Measurement Points; (b) Measurement Points Set Along Main Streets in Two Building Groups

Wind speed and direction data of the same day from the nearby meteorological station were used as inflow conditions and input to the 3D model of the current village for simulation. The CFD model was verified using measured data after simulation. Comparison of the measured values with simulated analog values (Table 1.) showed that variations at the measuring points were < 0.51 m/s (Fig.5.), and only point B had a 22.5° variation in wind direction. The differences between measured and analog values were small, indicating that the CFD model is reliable.

Table 1. Comparison of Wind Direction between the Measured Value and Simulated Values

Location	Measured	Simulated
A	NE	NE
B	NNE	N
C	WSW, WNW	WNW
D	N, NNW	N
E	NNE, N	NNE
F	NE, E	NE
G	N, NNW	N

4.2 Analysis of Simulation Results

4.2.1 Influences of the Surrounding Environment on the Wind Field of Huazhai Village

Due to its location advantages and the natural geographic conditions surrounding it, Huazhai Village

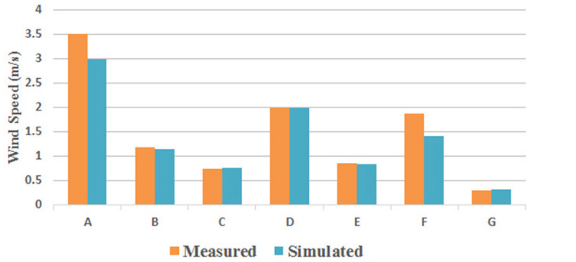
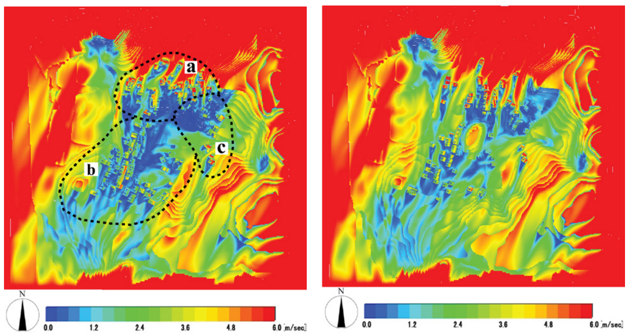


Fig.5. Comparison of Wind Speed between Measured and Simulated Values

can provide residents with a relatively favorable living environment in harsh climatic conditions. The wind on Wangan Island is strong in winter and the main wind direction is north-northeast. The wind speed surpasses the upper limit of tolerable gusts in residential areas of Taiwan. The hills on the north side of the village are the highest. Hills A and C (Fig.2.) can effectively reduce the speed of the wind before it enters the village. As shown by the distribution of the 1.5 m wind field in the current village during winter (Fig.6.), the average wind speed on the village periphery was 7.5 m/s, which declined to 3.15 m/s when the flow reached the weather side to the north of the settlement. When the wind encountered Hill F in the middle of the village, the average wind speed decreased to 1.3 m/s because the hill partially blocked the wind. The average wind speed on the leeward side in the south-southwest direction of the settlement was 0.6 m/s. This indicates that Hills A, C and F have remarkable influences on the wind field of the village in winter.



(a) current village (b) early village

Fig.6. Distribution of 1.5 m Wind Speed in Winter

The 1.5 m wind field on the street and plaza was further analyzed based on the current village simulation for winter. Most of the buildings were constructed in an area of elevation 2.3 m ASL, and wind speed on the street was 0.6–1.2 m/s. The largest plaza of the village is in this area and the speed there was 0.9–3.6 m/s (Fig.8.a). In the area at 6.3 m ASL with scattered buildings, the speed on the street was 0.9–2.7 m/s (Fig.9.a). Furthermore, the restored model of the early Huazhai Village was simulated to analyze the 1.5-m AGL wind field of the early settlement during winter. In the area where most of the buildings were, wind speed on the street was 0.9–2.4 m/s, and speeds on the

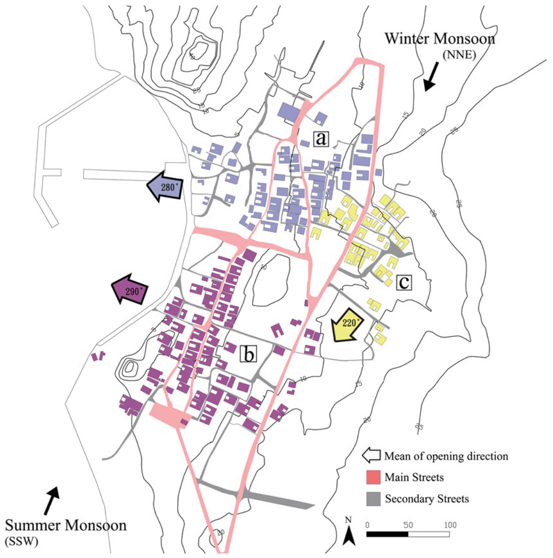
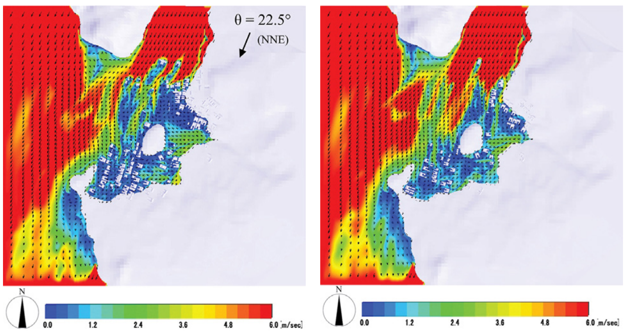


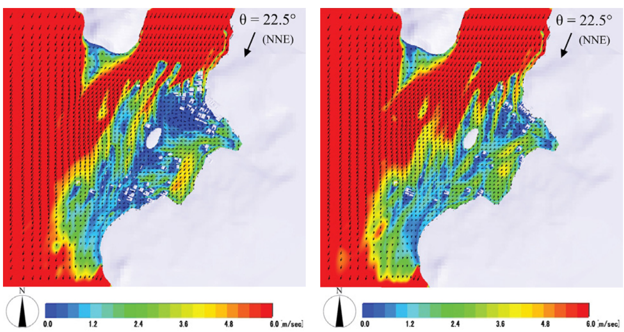
Fig.7. Current Configuration of Huazhai Village

plaza were 1.2–4.8 m/s (Fig.8.b). In other areas where buildings were scattered, wind speed on the street was 0.9–3.3 m/s (Fig.9.b).



(a) current village (b) early village

Fig.8. 1.5 m Wind Field at Elevation 2.3 m in Winter

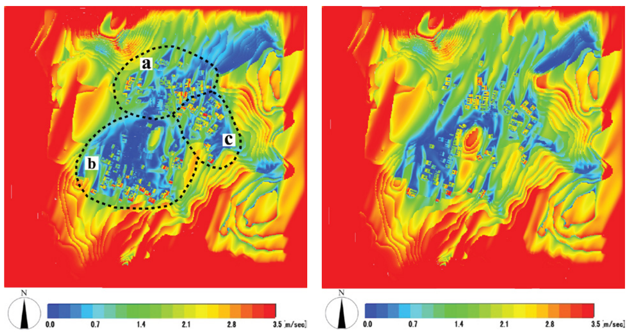


(a) current village (b) early village

Fig.9. 1.5 m Wind Field at Elevation 6.3 m in Winter

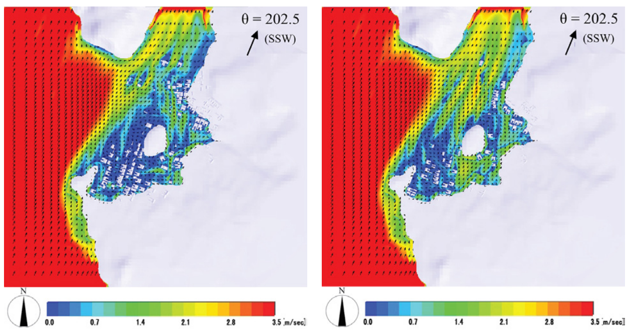
The wind direction is mainly south-southwest in summer. The lowest point without any hills is on the west side of the village, which faces the sea. The summer monsoon flowing from the sea can penetrate the settlement. As shown by the distribution of the 1.5-m wind field in the current village during summer (Fig.10.a), the average wind speed on the weather side of the village facing the sea was 2.1 m/s. The average wind speed on the weather side near Hill E on the southwest side was 1.06 m/s. This location had a larger area sheltered from the wind than the other locations. There were relatively few buildings in the early stage. Thus, the causes of wind sheltering at this location could be determined by comparing the wind field distribution of the current village and early settlement (Fig.10.). Hill E reduces the speed of the oncoming wind and the wind speed on the weather side was weaker than that in the coastal area, but most wind sheltering was caused by the close construction of the buildings.

Further analysis of the summer simulation results of the current village model showed that in the area with the majority of buildings, the speed of the 1.5 m AGL wind field on the street was 0.3–1.2 m/s, and that on the plaza was 0.3–0.9 m/s (Fig.11.a). In other areas where buildings were scattered, the speed of that wind field was 1.4–2.3 m/s (Fig.12.a). The restored model of early Huazhai Village was simulated to analyze its 1.5 m (AGL) wind field during summer. In the area with most buildings, wind speed on the street was 0.42–1.75 m/s, while that on the plaza was 0.7–1.75 m/s (Fig.11. b). In other areas where buildings were scattered, that wind speed was 0.7–2.1 m/s (Fig.12.b).



(a) current village (b) early village

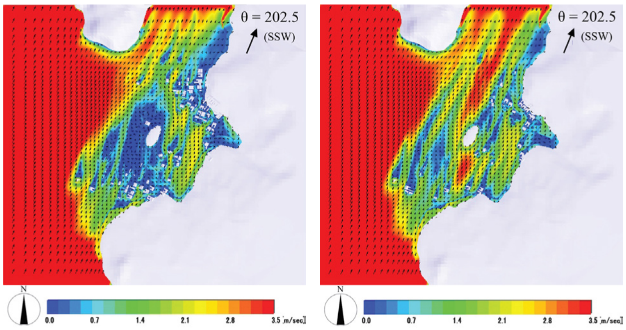
Fig.10. Distribution of 1.5 m Wind Speed in Summer



(a) current village (b) early village

Fig.11. 1.5 m Wind Field at Elevation 2.3 m in Summer

As indicated by the above discussion, the location of the village allows wind to be blocked in winter, and the wind speed of pedestrian-level wind fields on the streets and plaza is reduced to what is considered



(a) current village (b) early village

Fig.12. 1.5 m Wind Field at Elevation 6.3 m in Summer

in Taiwan to be a comfortable range. As there is no hill barrier where the village faces the sea, the summer monsoon flow from the sea can penetrate the settlement. The main street is at an angle of 22.5° to the prevailing wind direction (Fig.7.). It has been reported that the angle between the street and wind direction affects ventilation efficiency (Li, 2010). In the study village, when the wind blows through the street, its speed there exceeds the minimum value for environmental ventilation and increases the tolerance of residents to outdoor temperature.

4.2.2 Arrangement and Planning of Single Buildings and Groups of Buildings

Buildings in Huazhai Village were constructed using local materials such as coral reef rocks, basalt, and granite collected along the coast. With the main body built by laying stones and rocks, the buildings constitute rare traditional groups in Taiwan, with stone as the main structure. The buildings in this arrangement appear as a large rectangle composed of several small structures, in the middle of which is a courtyard. The rectangle has small openings facing outwards and has many large openings on the side that faces the courtyard. The main entrances and openings such as the gate and shaft door are arranged on the short sides of the rectangle. Secondary entrances and openings such as side doors and windows are arranged on the long sides. As the buildings are difficult to construct, serving as a wind barrier, and the economic conditions in the village are relatively poor, the traditional buildings are shorter and have smaller openings compared to the regular traditional buildings in Taiwan. Information on the buildings in each region is shown in Table 2.

Table 2. Mean Opening Direction and Number of Buildings in Each Region

District	Altitude	Mean of opening direction (360 degree)	Number of buildings
a	2.3m	280°	54
b	2.3m	290°	75
c	6.3m	220°	28

The majority of village buildings are at an elevation of 2.3 m ASL on the north and southwest side of the village (Fig.7., areas a and b). Most buildings face west to west-northwest. The building structure and openings are arranged at an angle of about 112.5° to the prevailing winter monsoon wind direction (NNE). In areas a and b, the long sides of the buildings are impacted by the winter monsoon flow. The comparatively fewer and smaller openings on the long sides of the buildings can reduce the courtyard and indoor wind speed of the buildings. The road passing through from north to south in areas a and b is the main street of Huazhai Village. Approximately, 92.8% of the buildings along this road have major openings toward the way to the sea. The main opening directions of these buildings are between 247.5°and 315°, which set up an angle about 67.5° with the wind direction of the summer monsoon (SSW, 202.5°). Other groups with fewer buildings are at an elevation of 6.3 m ASL on the northeast side of the village (Fig.7., area c), with most buildings facing south-southwest to southwest. Buildings in this area face away from the winter monsoon, with their main openings facing the summer monsoon, forming an angle of 22.5° with the summer wind. This enhances ventilation. These results demonstrate that the planning and design of the village buildings were aimed at resisting the winter monsoon using the building structure and allowing passage of summer winds through their main openings.

The simulation results (Figs.6., and 10.) of the current village and early settlement were further compared. The number of village buildings has increased over time. The range of wind sheltering has also increased, especially on the southwest and northeast sides. In winter, the area of wind sheltering mainly increased on the northeast side (Fig.6., area c), followed by the southwest side (Fig.6., area b). As the northeast was the weather side where the winter monsoon blew into the village and the southwest side was where the main village buildings and streets were distributed, an increase in wind sheltering could reduce wind speeds in areas with the strongest winter wind and in the main public activity space in the village. In summer, the area of wind sheltering mainly increased on the southwest side (Fig.10., area b). The average wind speed in this area was 0.46 m/s, which is less than 1.4 m/s: the average wind speed to the north and northeast of the leeward side (Fig.10., areas a and c). This is to the disadvantage of ventilation. As shown by the analysis of the distribution of the current village and early settlement, except for part of the buildings on the southwest and northeast sides that expanded outward, all the newly constructed buildings were orderly and closely arranged with the early buildings. There were other open spaces in the village and new groups of buildings could have been constructed in a dispersed manner. However, the buildings were orderly and closely spaced. All the main openings of the buildings did not face the main street. Instead, some of the buildings exits faced the main street. The direction of opening was adjusted according to micro-topography, and there was a unified direction of opening in each region. Such arrangement must serve a specific purpose. A better arrangements could have been made for commercial reasons, or to increase shade, temperature, humidity, light, and other factors. Based on the above discussion, it is speculated that the planning principles of the buildings gave first priority to wind sheltering, indicating that winter monsoons had an immense impact on the residents. The focus of this planning was to alleviate wind damage.

5. Conclusions

Huazhai Village clearly reflects the ancient Chinese pursuit of harmony between buildings and the natural environment, and the ecological philosophy originating from traditional *feng shui* knowledge. From the analysis of the village, the ecological wisdom of ancient people in dealing with wind, the characteristic weather condition in the area, was clearly demonstrated. According to the simulation of CFD and the analyses of the buildings, there are three principles. First, topography and water are closely related to the residence sites chosen using *feng shui*. Topography and water are two key elements to consider during site selection to enhance the quality of the living environment. Second, while planning the construction of settlements, residents will observe the wind in the area. They will take into consideration the long-term wind directions in their planning so that streets are not constructed parallel to the main wind direction, but rather as wind corridors. Third, buildings are not arranged in the same direction, density, or order. They should be arranged according to the micro-topography, regional demand, and characteristics of the wind field in the settlement.

The wisdom of ancient Chinese people enables residents to live in harmony with nature and create a sustainable living environment that adapts to the climate. In terms of modern design strategies, Huazhai Village has a residential area with low-rise buildings and it was built according to the topography. Hence, it can be a reference for planning groups of villas, concentrated housing, and rural communities.

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