Strategy Analysis on Integrating Urban Heat Island Mitigation and Environment Resource Management Using Multivariable Method

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Abstract: -In this study, we present the strategy analysis framework for integrating urban heat island (referred as UHI) and environment resource management in rural community while it aims a sustainable goal, in Miaoli, Taiwan. This is essentially a data reduction technique and will suggest strategy (critical variables) by factor analysis to explain the observed variances in this study. Results show that fifteen factors can be deduced from four themes. These four themes are: (1) land development and building greening; (2) natural resource maintenance; (3) keeping good environment resource; and (4) concerning natural ventilation and energy saving. The variations expressed by the data in Miaoli, Taiwan, can be collectively accounted for 23.582%, 41.682%, 57.158% and 68.118%, for the four aforementioned themes respectively.

Key-words: FAHP, Ecological preservation, Multi-stage objectives model, Optimal policy, Network.

1 Introduction
In a complicated and dynamic world, it is important and urgent to interpret these phenomena and integrate information into usable forms or strategy [1] to effectively manage this information. In order to depict and reflect the ecological, economic, social, and institutional indices of sustainable community development, StoneWall community located at Miaoli county, Taiwan was surveyed as an example to develop a sustainable community development strategy [21, 23, 25]. We integrated environment resource management from the urban heat island mitigation perspectives on aiming toward sustainable community, a factor analysis methodology is developed to guide case study research into the processes.

Recently Taiwan nearly all cities are experiencing a serious heat-island effect impact [2, 4, 26] and diurnal temperature over Taiwan has decreased by about 1.1 degrees since 1950, due to a rapidly industrializing society, about twice the corresponding values over major continents [3–4]. Rural land use rapid change has been shown to be a significant threat to rural ecosystems [5–6, 21–23], yet the understanding of linkages between urban heat island mitigation and environment resource maintain is limited.

Rural society, such as Miaoli county, is in a crucial transformation process towards a more urban style. The trend is happening simultaneously with directly increasing pressure on Miaoli county environment. In sustainable community study, García-Barriosa, et al., and Wu, et al., [7, 24] indicated a framework pioneered a multidisciplinary and fact-based evaluation of the sustainability of specific natural resource management systems, most commonly by comparing a conventional versus an alternative management strategy. Bakti and Sudharto [8] analysed the weaknesses of current environmental policies and programmes in Indonesia gave too dominant a role to the government and neglect civil society’s involvement in natural resources and environmental management.

In urban heat island researches, Lin et al., [9] stressed that the phenomena of urban high-density development that has already expanded to surrounding rural area, in Taiwan. Many studies attempted to analyze mitigation factors influencing urban heat island effect, such as Murakami et al., [10] pointed out that Asian mega cities have experienced rapid population growth and will continue to expand. Lin et al., [11] applied multivariable parameters
analysis technique in the Neihu campus community of Taipei city while toward a green campus community. He found six middle dimensions are: (1) preservative area and total greening building; (2) air quality and ventilation; (3) rain infiltration and storm mitigation design; (4) low sensible heat building; (5) natural resource utility; and (6) economic management and environmental education. The six middle dimensions can be ranked and weighted collectively for 23.70%, 20.60%, 19.70% 17.50% 10.50% and 8.00 % for the six aforementioned dimensions, respectively. Also, Takebayashi, et al., [12] studied the surface temperature, net radiation, water content ratio, etc., of green roofs and high reflection roofs are observed.

In related researches of environment resource management, factorial analysis was adopted to detect affinities between sites with similar epiphytic composition and various environmental variables [13]. Karen et al., [14] compared biogeochemical data from three synoptic sampling events representing the temporal variability of baseflow chemistry and land use using R-mode factor analysis. Liu, et al., [17] pointed out that sustainable fishery development indicator system is a good reference that reflects fishery variations at different times and locations, and show the time variation of each indicator and indicates sustainable trend at each developmental stage. Chena, et al. [18] indicated some potential land use scenarios, based on surveys on biophysical and socio-economic parameters in the catchment. Kuppusamy, et al., [16] used factor analysis to study water quality parameters in order to explain the pollution status of Chennai Ennore coastal environmental system. Wayland, et al., [19] used R-mode factor analysis to examine the usefulness of the synoptic sampling approach for identifying the relationship between complex land use configurations and stream water quality. And Liu [15] used factor-analysis to study environment-quality indicators for large metropolitan areas. Overall, In this research we concerned: (1) to analyze critical factor integrating UHI mitigation and the environment resource management in StoneWall community, Miaoli; (2) a factor analysis methodology is developed to guide rural sustainable community.

2 Site and Method
In this study, above questionnaire total 68 copies were directly delivered to opinion leader in community, experts and scholar and residents, and we recovered 56 copies. Its recovery rate is 82.4%. Factor analysis has been used in the present work. This is essentially a data reduction technique and will suggest how many variables important to explain the observed variances in the data. The possible variances in the urban heat island mitigation parameters may be due to either sources of anthropogenic origin or natural variances due to different development processes in this community.

In this study, we hope to analyze strategy factors concerning UHI mitigation by questionnaire of community residents and experts. It is important to help people understand the dynamic nature of sustainability attributes and to better address the issues, tradeoffs and conflicts associated with sustainable management of natural resources [7, 20–21, 25]. All residents in StoneWall community are interested in the long term persistence of these environment resources to attain: (1) a better understanding of how the building rules to respond in mitigating to management practices and (2) a mind open to collectively designing strategies that take into account these responses and the interests of all residents involved.

2.1 Site
Miaoli county located on northern Taiwan, Community development are mostly rural type community. Because government only shared a limited fund to local and lacked long terms sustainable development, and local residents is not sufficient catching enough information, that led the development speed is slower than other counties. Miaoli is in the pivotal position of the Asia-Pacific region Miaoli County is located in the mid-northern coast of western Taiwan (Fig. 1). The total area is 1,820 sq. km., accounting for 5.06% of the total area of Taiwan. It faces Taiwan Strait in the west.

Our study aim to investigate StoneWall community, Miaoli, located in the Northern part of Taiwan (Fig. 1). This community is near Holung River and its antiquated architecture in StoneWall community has been suffering from serious destroying for a long time, which originated in a original residents several hundred years ago. The rapid increase in human activity has led to more areas became used for grain production. After surveying this community and its dwellers, we found two main problems when promoting to establish the community’s sustainability: (1) it is not properly planned or preserved in urban heat island mitigation, such as building materials, and community development, cultural-historical sites; and (2) there is
no clear plan for community environment resource management.

2.2 Method
The procedures for this survey include three steps: (1) compute benchmarks for each hierarchy dimension to obtain the weights for each sustainable benchmark; (2) after crossing over each dimension and hierarchy benchmark weight value, the absolute weight value for each sustainable benchmark is obtained; and (3) benchmarks of relative importance and absolute importance can be ranked to derive the ranking importance based on the corresponding weight value and absolute weight value. Research flow chart of toward a UHI mitigation for a sustainable community study using factor analysis method in Miaoli county of Taiwan was shown in Fig. 2.

Overall, this system established three levels: (1) upper level hierarchy; (2) middle level hierarchy; and (3) low level hierarchy including fifteen UHI mitigation benchmarks. Fig. 3 indicates the strategic analysis framework in three levels goal tree included 15 factors for a sustainable community in the Miaoli, Taiwan. Then these benchmarks weighting values were computed for each of the hierarchy levels. Controlling rural land development pave is a significant factor in making a sustainable land use planning for this community. In this study, a procedure towards such a planning is presented, based on questionnaire using factor analysis. A UHI mitigation evaluation for rural community based on environment resource management, and a strategy (critical factors) between UHI mitigation and current environment resource use, were first carried out.

3 Investigations and Analyses
In field research the data were randomly surveyed by means of face-to-face interviewing with people who are familiar with StoneWall community, participants coming from experts and local villagers. Total 56 valid samples were collected using the comprehensive structured questionnaire during January to October 2007. The content of questionnaire was designed for community villagers who promoted sustainable community, and that consisted of two parts, one is urban heat island [19,20] in terms of environment, the other is environment resource in terms of maintain community natural resource. Totally there are four themes referred to literature [1–5, 7, 10–12, 14, 18] in this questionnaire, including (1) land development and building greening; (2) natural resource maintenance; (3) keeping good ecological resource; and (4) concerning natural ventilation and energy saving. The answers were adopted by Likert’s five-point scale, from strongly agree (mark 5) to strongly disagree (mark1) and then were summed to count total score (attitude). Four themes of factor analysis and related variables in environmental resource and urban heat island effect in this study were presented at Table 1. Factor analysis can test the construct validity of the questionnaire that refers to how the attitude scale can check theoretical concept or characteristic degree. The objective of factor analysis is to find potential strategy (factors) in the scale, by decreasing the number of questions using principal components analysis that could result in a better correlation coefficient. We selected common factors when eigenvalue is greater than 1; and deleted those if the factor loadings are less than 0.40. Then we use varimax rotation to form orthogonal rotation (Fig. 2).

4 Results and Findings

4.1 Theme of land development and building greening and Associated Factors
Due to rapid urbanization, the construction material of cement and asphalt etc can be found everywhere in this community. It is very urgent to concern the environmental conservation and creation of reconstruction of the biological habitat. Therefore the land development and building greening concept was adopted as first theme and five factors were extracted from this theme: (1) ecological land use; (2) greening surface and outer wall; (3) greening balcony in building; (4) building roof garden; and (5) promoting biodiversity. “Land development and building greening ” theme has a total of three factors extracted with 23.582% of cumulative variance explained value. The most important factor in “Land development and building greening” theme is “greening surface and outer wall” variable (0.845) (Table 1).

4.2 Theme of natural resource maintenance and Associated Factors
In recent decades, this community original vegetation has been destroyed and the community location is near Holung River where is becoming more and more serious flooding risk. In addition, it is not far from the city center there is no land long term planning around that by the county government and the community organization. In addition local farmers are confronted with highly competition with foreign agricultural goods since Taiwan joined WTO. As the profit
dwindled, many farmers went away from their farmlands, eventually both living quality and its ecological environment got worse [23]. Nevertheless, sustainable community concerning protecting farm resources and promoting effective farm use is a good resolution to avoid continuing deterioration of living environment. Using factor analysis the factor loads of 0.5 or more were chosen and are shown in Table 1, and the following factors (variables) were extracted: (1) agricultural resource conservation; (2) maintenance degree of conservation area; (3) reduce runoff of surface water; and (4) water consumption yearly average each person. “Natural resource maintenance” have two factors with 41.682 of cumulative variance explained value. The most important factor in “Natural resource maintenance” theme is “agricultural resource conservation” variable (0.751).

4.3 Theme of keeping good environment resource and Associated Factors
Effective communication between local resources and integrated government and professional organization can set up agricultural planning in a healthy and vibrant countryside, i.e. maintaining local ecological resource. “Keeping good ecological resource” was extracted five factors with 57.158 of cumulative variance explained value. The most important factor in “keeping good environment resource” theme is “CO2 mitigation” variable (0.751).

4.4 Theme of concerning natural ventilation and energy saving and Associated Factors
To encourage “Layout of low heat accumulated [11]”, a comprehensive private and public building planning will be proposed to maintain more energy saving design concerning UHI mitigation in order to reduce pollutant distribution by building form design [3], as well as the needs of energy [22]. “Layout of low heat accumulated” extracted five factors with 68.118 of cumulative variance explained value. The most important factor in “concerning natural ventilation and energy saving” theme is “Efficient ventilation in building” variable (0.751). The factor loads of 0.5 or more are chosen and shown in Table 1.

5 Conclusion
This paper investigates environment resource planning and policy innovations from urban heat island mitigation standpoint. Results show that fifteen factors can be deduced from four themes. These four themes and associated factors concerned UHI mitigation are: (1) land development and building greening: ecological land use, greening surface and outer wall, greening balcony, building roof garden, and increasing biodiversity; (2) natural resource maintenance: agricultural resource conservation, maintenance degree of conservation area, reduce runoff of surface water, and water consumption yearly average each person; (3) keeping good ecological resource: safe drinking water quality, development process not deteriorating air quality, selecting material of low CO2 emission, and reducing land development area; and (4) concerning natural ventilation and energy saving: adopting efficient natural ventilation, and low heat accumulated layout. The variations expressed by the data in Miaoli, Taiwan, can be collectively accounted for 23.582%, 41.682%, 57.158% and 68.118 %, for the four aforementioned themes respectively. The results of this study have significant implications for agricultural planning and decision making in an effort to develop sustainable community in Miaoli county of Taiwan, and this methods described here can be used in other area.

Acknowledgement
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References:


Fig. 1. Location of StoneWall community in Miaoli county, Taiwan.

Fig. 2. Research flow chart of toward a UHI mitigation for a sustainable community study using factor analysis method in Miaoli county of Taiwan.
### Table 1 Factor analysis of variable in environmental resource and urban heat island effect.

<table>
<thead>
<tr>
<th>Environmental resource and urban heat island effect Variable</th>
<th>Factor 1: Land development and Building greening</th>
<th>Factor 2: Natural resource maintenance</th>
<th>Factor 3: Keeping good environment resource</th>
<th>Factor 4: Concerning natural ventilation and energy saving</th>
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</thead>
<tbody>
<tr>
<td>Agricultural resource conservation in environmental resource</td>
<td>0.751</td>
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<tr>
<td>Maintenance degree of conservation area in environmental resource</td>
<td>0.747</td>
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<tr>
<td>Reduce runoff of surface water</td>
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<tr>
<td>Water consumption yearly average each person in environmental resource</td>
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<td>Safe drinking water in environmental resource</td>
<td>0.506</td>
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<td>Air quality influenced by development in environmental resource</td>
<td>0.636</td>
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<td>CO₂ mitigation in community in environmental resource</td>
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<td>UHI mitigation by reduced land development area</td>
<td>0.531</td>
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<tr>
<td>UHI mitigation by using ecological land use concept</td>
<td>0.553</td>
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<tr>
<td>UHI mitigation by greening of surface and wall in environmental resource</td>
<td>0.845</td>
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<tr>
<td>UHI mitigation by greening balcony in environmental resource</td>
<td>0.810</td>
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<td>UHI mitigation by building roof garden</td>
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<td>UHI mitigation by promoting biodiversity</td>
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<tr>
<td>UHI mitigation by efficient ventilation in architectural</td>
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<td>0.849</td>
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<td>UHI mitigation by low heat accumulated layout</td>
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<td>0.627</td>
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<td>Eigencevalue</td>
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<tr>
<td>% of cumulative variance</td>
<td>23.582, 41.682, 57.158, 68.118</td>
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</tbody>
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Fig. 3. The strategic analysis framework in three levels goal tree included 15 factors for a sustainable community in the Miaoli, Taiwan.