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Consideration Factors of Moving to a New Destination for Coastland Residents Under global Warming

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***Abstract*—**Because of the global warming and the rising sea level, residents living in southwestern coastland, Taiwan are faced with the submerged land and may move to higher elevation area. It is desirable to discuss the key consideration factor for selecting the migration location under five dimensions of " security", "health", "convenience", "comfort" and "socio-economic" based on the document reviews. This paper uses the Structural Equation Modeling (SEM) and the questionnaire survey. The analysis results show that the convenience is the most key factor for residents in Taiwan.

***Keywords*—**global warming; migration; structural equation modeling; questionnaire survey

I. Introduction

THE climate change and natural hazard are the major challenge in the twenty century. The human activates fasten the negative impact of climate change and natural hazard. The global warming is a significant example. The continued global warming will cause the rising sea level and the coastland around the world may be submerged. Humans are facing the dilemma of the selection of returning to the original place of residence or migrating to a new destination. It is encouraged to move to a new location for safe and suitable life. Therefore, the guarantee of environment livability is very important for the disaster-affected resident.

Taiwan is an island located in Pacific Ocean. The southwest coastland, Taiwan in which population and industry are concentrated may be submerged and migration will be unavoidable if the global warming occurs continuously. However, the higher elevation area close to the southwest coastland is mudstone area, which has the vulnerable geology environment. It is necessary to select a new dwelling location carefully for residences in southwest coastland, Taiwan. There have been a lot of studies to define the factors of dwelling environment (e.g. World health organization, 1961; [2], 1987; Sun, 1994).

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The concepts of suitable development are also involved in the sustainability of dwelling environment. This paper aims to present the consideration factors of moving to another location for residences living in southwest coastland, Taiwan. In this paper, the influence factors of location selection are first collected based on literatures. The Structural Equation Modeling (SEM) and the questionnaire survey are used to understand residences' opinion. The analysis results can be used as a reference in the resettlement task under the global warming.

II. Literature Review

A. Dwelling environment

There are a lot of consideration factors for selecting a suitable dwelling location. The World Health Organization (WHO) proposed four factors including security, health, convenient and comfort from the viewpoint of enjoining the health living environment and satisfying routine needs. The security is the human can be away form the disaster, and life and property are protected. The health is the human body and spirits are protected away from injury. The convenience is the convenience of life is ensured in rational economic condition. The comfort is the beautiful environment and relaxed body and mind is guaranteed fully. In addition, the concept of sustainable development is involved in the sustainability of dwelling environment. In literature, there are three levels of environmental suitable indicators. There are region, city and community levels (e.g. OECD environmental indicator, 1994; Sustainable Seattle, 1993). [1]developed a system approach for a sustainable community. Chen (2010) collected many documents about good dwelling environment [2, 4] and proposed an evaluation model composed of security, health, convenience, comfort, and socio-economic for selecting a suitable migration location.

B. Environment characters in mudstone are, Taiwan

In the hill area, more then 1000 km2 area located in Tainan and Kaoshiung counties in southern Taiwan is covered by a young and weakly cemented mudstone formation. The characteristics of mudstone slope are sensitive in slaking and weathering, with high erosion rate, and the strength decreased when the water content increased. Owing to the se special characteristics, addition to heavy rain of typhoon and active fault, the disaster, such as sliding, debris flow and erosion, and

also resulted in reducing the life of the reservoir etc. occurs frequently in the mudstone hill (Lee et al, 1994).

III. Components and Factors for Selecting Suitable Dwelling Locations

An evaluation structure of migration including five components (a total of 29 factors) is pre-determined based on the environmental characteristic in the southwestern mudstone area, Taiwan and sustainable environment concept listed in Table I. Next, a total of 100 experts' questionnaires in the fields of sustainable development, environmental ecology, disaster planning and land use are selected to investigate the experts' recognition of components and factors. There are 56 questionnaires responded. A threshold is adopted in this paper. Some component with the sum of more than 10% in two columns of "disagreeable" and "very disagreeable" will be deleted, as well as some factor. Finally, 5 components consist of 24 factors are selected based on the experts' opinion.

The investigation results of agreement levels (see Table II and Table III) are illustrated as follows.

TABLE I
CONSIDERATION FACTORS FOR SELECTING A NEW DWELLING LOCATION

components	factors
security	rock type, soil type, active fault, slope, aspect, debris-flow potential, landslides, density of water system, historic geological hazard
health	water quality of reservoir, water quality of river, density of NIMBY facilities, number of existing factory registration, average daily volume of cleared garbage
convenience	distance to city central, density of main lines, water penetration, density of public facilities
comfort	rainfall, ventilation, temperature, Green Coverage Ratio
socio-economic	land area of limited development, Agricultural production per unit area, rice production per unit area, arable area, density of population growth, implementation of community development work, business case for mediation

- Based on the experts' agreement levels, the 5 components are adopted in this paper.
- There are 7 factors kept in the security component except for factors of rock type and soil type. The reason is the locations people will move to is all in the southwestern mudstone, Taiwan and the less variability in rock type and soil type exist.
- There are 4 factors kept in the health component except for the factor of average daily volume of cleared garbage. Most respondents indicate that the volume of cleared garbage is affected by individual behavior, as well as governmental policy of environment.
- There are 4 factors kept in the convenience component because all factors pass through the check of threshold.
- There are 4 factors kept in the comfort component, as same as the convenience component.
- There are 4 factors kept, 1 factor modified and 2 factors deleted in the socio-economic component. Some respondents mean that the factors of agricultural production per unit area and rice production per unit area are highly correlated. Thus, the factor of rice production per unit area is deleted and the factor of agricultural production per unit is kept in this paper. Besides, the factor of business case for mediation, which is relevant to individual dispute act, is also deleted. The factor of density of population growth is modified to the factor of growth of population density for clearing the definition.

Based on the forward analysis results, 24 factors are kept. It is considered that 5 factors (aspect, water quality of reservoir, distance to city central, agricultural production per unit area, and agricultural production per unit area) with less variability in the mudstone area may be deleted further. Finally, only 19 factors are used in this paper.

TABLE II
AGREEMENT LEVELS OF 5 COMPONENTS

component	very agreeable (%)	Agreeable (%)	common (%)	dis-agreeable (%)	very dis-agreeable (%)	Remark
security	64.29	25.00	5.36	1.79	3.57	accept
health	26.79	53.57	10.71	8.93	0.00	accept
convenience	19.64	53.57	21.43	5.36	0.00	accept
comfort	17.86	57.14	17.86	5.36	1.79	accept
socio-economic	23.21	48.21	21.43	5.36	1.79	accept

IV. Results and Discussions

A. Respondent statement

The residences living the coastland area, located in southwest Taiwan are sampled as the objective of questionnaires survey. There are 22 districts listed in Table IV are investigated. The Stratified random sampling is adopted based on the proportion of population and a total of 900 questionnaires are collected. The data of questionnaires survey is during December, 2010 to March, 2011. The value in the column of population in Table IV is from the 2010 years' demographic data of the Household Registration Office, Taiwan.

Table V is the basic data of respondents. There are 48.6% female and 51.4% male. The distribution of sampled age is uniform approximately. In the education level, more than half of respondents were graduated from the college. The respondents with more than 16 living years have 61.5%. It is meant that respondents have the deep image for the living environment.

B. Development of SEM

The Structural Equation Modeling (SEM) is adopted to acquire the key factors of consideration when residents in coastland are expected to move to another location facing the global warming. Fig. 1 is the initial structural modeling. The variable of location selection is the exogenous latent variables and the 5 components of security, health, convenience, comfort and socio-economic are the endogenous latent variables. Others marked by rectangular are the observation variables. It is found that Chi-Square degree ratio of freedom is equal to 4.42 (>3). Thus, the initial model (Fig. 1) should be revised. The revised model is shown as Fig. 2. The fit indices show that the revised model is acceptable.

TABLE III
AGREEMENT LEVELS OF 29 FACTORS

factor	very agreeable (%)	Agreeable (%)	common (%)	dis-agreeable (%)	very dis-agreeable (%)	Remark
security						
rock type	10.71	35.71	39.29	8.93	5.36	delete
soil type	8.93	46.43	28.57	14.29	1.79	delete
active fault	55.36	33.93	7.14	1.79	1.79	accept
slope	53.57	41.07	3.57	0.00	1.79	accept
aspect	42.86	32.14	21.43	1.79	1.79	accept
debris-flow potential	66.07	23.21	1.79	8.93	0.00	accept
landslides	66.07	28.57	1.79	1.79	1.79	accept
density of water system	17.86	57.14	21.43	1.79	1.79	accept
historic geological hazard	57.14	32.14	3.57	5.36	1.79	accept
health						
water quality of reservoir	30.36	44.64	17.86	5.36	1.79	accept
water quality of river	21.43	51.79	21.43	3.57	1.79	accept
density of NIMBY facilities	8.93	57.14	32.14	1.79	0.00	accept
number of existing factory registration	8.93	66.07	16.07	7.14	1.79	accept
average daily volume of cleared garbage	5.36	14.29	51.79	25.00	3.57	delete
convenience						
distance to city central	23.21	51.79	16.07	5.36	3.57	accept
density of main lines	21.43	50.00	21.43	7.14	0.00	accept
water penetration	23.21	48.21	19.64	7.14	1.79	accept
density of public facilities	23.21	55.36	14.29	7.14	0.00	accept
comfort						
rainfall	19.64	53.57	19.64	5.36	1.79	accept
ventilation	17.86	53.57	19.64	8.93	0.00	accept
temperature	30.36	44.64	19.64	5.36	0.00	accept
green coverage ratio	37.50	37.50	19.64	5.36	0.00	accept
socio-economic						
land area of limited development	23.21	42.86	26.79	7.14	0.00	accept
Agricultural production per unit area	14.29	28.57	48.21	8.92	0.00	accept
rice production per unit area	7.14	33.93	35.71	21.43	1.79	delete
arable area	19.64	41.07	30.36	8.93	0.00	accept
density of population growth	25.00	39.29	26.79	8.93	0.00	modify
implementation of community development work	12.50	50.00	28.57	3.57	5.36	accept
business case for mediation	7.14	14.29	44.64	26.79	7.14	delete

TABLE IV
RESULTS OF QUESTIONNAIRES

district	number of population	proportion	predicted samples	actual samples
Siaobang	154,424	0.10	104	91
Cijin	29,969	0.02	18	18
Cianjhen	75,654	0.05	47	44
Ling-Ya	184,289	0.12	141	109
Cianjin	28,955	0.02	17	17
Yencheng	27,434	0.02	16	16
Gushan	131,578	0.09	95	77
Tzuoying	191,735	0.13	115	113
Nanxih	61,838	0.04	41	36
Linyuan	70,506	0.05	54	42
Jiading	31,475	0.02	19	19
Yungan	14,225	0.01	8	8
Mituo	40,453	0.01	12	12
Zihguan	36,758	0.02	23	22
Annan	177,960	0.12	122	105
Anping	62,520	0.04	38	37
South	126,293	0.08	80	74
Tnpm	12,490	0.01	7	7
Jiangjiun	21,613	0.01	13	13
Chigu	24,810	0.02	15	15
Jiadong	21,424	0.01	13	13
Linbian	20,910	0.01	12	12
Total	1,527,313	1	1010	900

TABLE V
BASIC DTAT OF RESPONTENTS

variable		number of respondents	proportion (%)
Sex	female	437	48.6
	male	463	51.4
Education	research institute	72	8.0
	college	530	58.9
	senior high School	141	28.0
	junior high school	46	5.1
Profession	Industry	131	14.6
	Public service	176	19.6
	Others	44	4.9
	Services	267	29.7
	Animal husbandry	3	0.3
	Unemployed	59	6.5
	Soldier	49	5.4
	Teacher	29	3.2
	Agriculture	9	1.0
	Fishery	5	0.6
	Students	128	14.2
Age	20 to 25 years old	176	19.6
	26 to 30 years old	162	18.0
	31 to 35 years old	119	13.2
	36 to 40 years old	121	13.4
	41 to 45 years old	111	12.3
	46 to 50 years old	101	11.2
	51 to 55 years old	70	7.8
	56 to 60 years old	40	4.4
Living years	0 to 5 years	91	10.1
	6 to 10 years	134	14.9
	11 to 15 years	121	13.4
	16 to 20 years	153	17.0
	21 to 25 years	145	16.1
	26 years and over	256	28.4

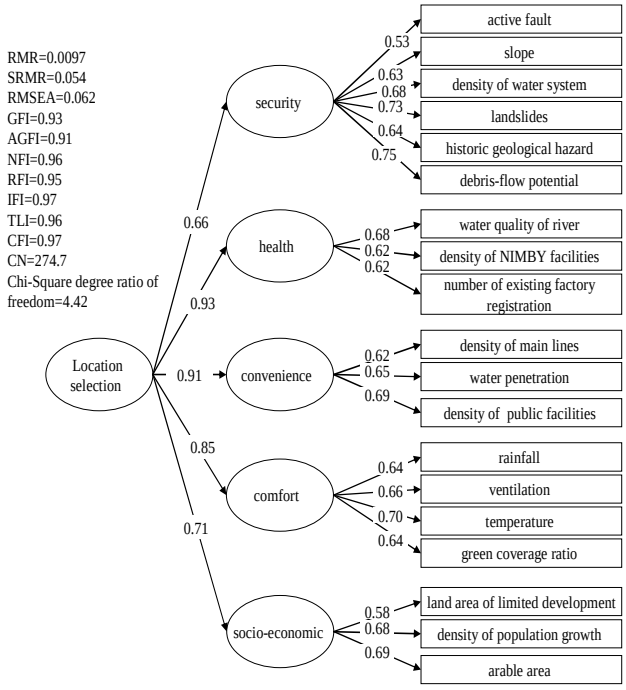

Fig. 1 Initial model

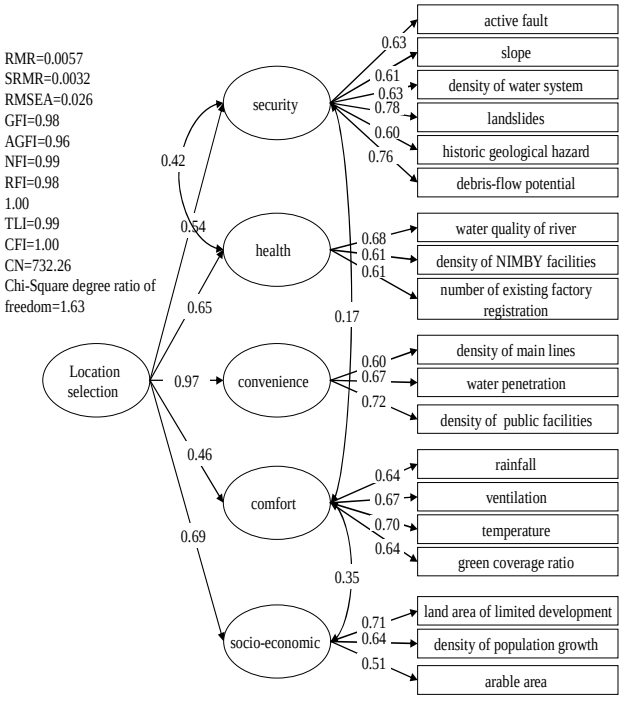

Fig. 2 Revised models

Table VI is the estimated parameter of the revised SEM. The factors with a predicted value of less than 0.4 are slope, density of water system, historic geological hazard, density of NIMBY facilities, number of existing factory registration, density of main lines and arable area. The factors with a predicted value of 0.4 to 0.6 are active fault, debris-flow potential, water quality of river, water penetration, density of public facilities, rainfall, ventilation, temperature, green coverage ratio, density of population growth and land area of limited development. Only landslide has a higher predicted value. Table VII is the weight values of components and factors. Among the components, the component of convenience has a higher weight value. It is shown that residences in coastland area have higher importance on convenience.

TABLE VI
ESTIMATED PARAMETER

Endogenous latent variables	Standardized parameter values	Observation variables	Standardized parameter values	Measurement error	R-squared
Security	0.54	active fault	0.63	0.60	0.40
		slope	0.61	0.63	0.37
		density of water system	0.63	0.61	0.39
		landslides	0.78	0.39	0.61
		historic geological hazard	0.60	0.64	0.36
		debris-flow potential	0.76	0.42	0.58
Health	0.65	water quality of river	0.68	0.54	0.46
		density of NIMBY facilities	0.61	0.63	0.37
		number of existing factory registration	0.61	0.62	0.38
Convenience	0.97	density of main lines	0.60	0.64	0.36
		water penetration	0.67	0.55	0.45
		density of public facilities	0.72	0.48	0.52
comfort	0.46	rainfall	0.64	0.59	0.41
		ventilation	0.67	0.54	0.46
		temperature	0.70	0.51	0.49
		green coverage ratio	0.64	0.58	0.42
socio-economic	0.69	land area of limited development	0.71	0.50	0.50
		density of population growth	0.64	0.59	0.41
		arable area	0.51	0.74	0.26

V. CONCLUSION

In this paper, a new evaluation model is developed to assess a suitable migration location. By experts' questionnaire results and local environment, Taiwan, five component including security, health, convenience, comfortable and socioeconomic and 19 factors are adopted. A total of 900 questionnaires are investigated further to understand residences' opinion. By the Structural Equation Modeling, the analysis results show the component of convenience is the most important when residences have to move to another dwelling location under the threat of global warming.

TABLE VII
WEIGHT VALUES

component	Weight value (A)	factor	Absolute weight value (B)	Relative weight value (C=A×B)
Security	0.163	active fault	0.157	0.026
		slope	0.152	0.025
		density of water system	0.157	0.026
		landslides	0.195	0.032
		historic geological hazard	0.150	0.024
		debris-flow potential	0.190	0.031
Health	0.196	water quality of river	0.358	0.070
		density of NIMBY facilities	0.321	0.063
		number of existing factory registration	0.321	0.063
Convenience	0.293	density of main lines	0.302	0.088.
		water penetration	0.337	0.099
		density of public facilities	0.362	0.106
comfort	0.139	rainfall	0.242	0.034
		ventilation	0.253	0.035
		temperature	0.264	0.037
		green coverage ratio	0.242	0.034
socio-economic	0.208	land area of limited development	0.274	0.057
		density of population growth	0.344	0.072
		arable area	0.382	0.079

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