How much does 1 degree Celsius worth? - The economic value of paddy field Heat Sink Effect evaluate by the Contingent Valuation Method

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Content

1.Introduction

The global average temperature increase is expected to exceed 3 degrees Celsius (°C) before the end of the 21st century

Taiwan's sea level rise will exceed 3 centimeters after 10 years, which will eventually aggravate environmental problems in coastal areas.

Agricultural lands, green spaces, or water surfaces have relatively lower temperatures compared to peripheral areas and have a cooling effect.

Facing the global warming problem, the existence of paddy fields may be one of the natural solutions to the regional temperature mitigation.

The paddy cultivation, compared with other vegetation, may have more functions such as production, ecology and social lives.

This study evaluate the economic value of paddy field heat sink effect by contingent valuation method.

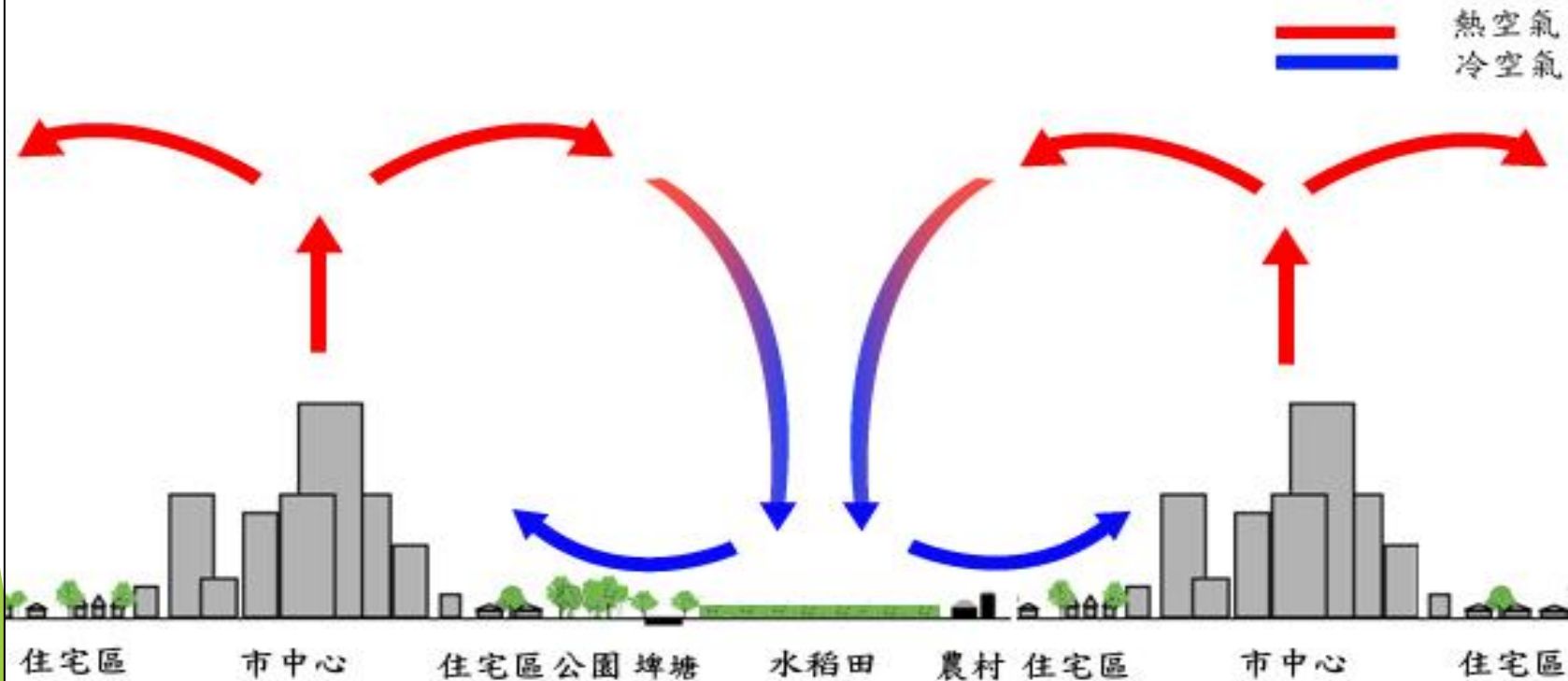# 2. Heat Sink Effect in Paddy Fields

Heat Sink Effect in Paddy Fields
Paddy heat sink effect–
The schematic diagram of changes of cold air and hot air

水田熱匯效應(Paddy Heat Sink Effect)

熱空氣
冷空氣

住宅區　　　市中心　　住宅區 公園 埤塘　水稻田　農村 住宅區　　市中心　　　住宅區

Tan and Hsu used satellite telemetry to carry out observation of large areas of urban and paddy field areas in Taiwan.
It was found that if 11% of the paddy field in one rice cultivation area is developed into an urban area, the temperature in the region will increase by 1°Celsius .

3.Contingent Valuation Method

Contingent Valuation Method

Questionnaire Design

Sampling

Contingent Valuation Method (CVM)

CVM
express people's preference for wealth and goods in monetary amounts.

Paddy fields with the temperature regulation function are not general wealth and goods in the sense that there are no real markets or transactions.

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CVM - Theoretical and Empirical Model

- $S = S(P_W, P_X, S_O)$.
- $Y(Q0, Q1, U0, S) \geq T$
- $Pr = Pr[Y^*(Q0, Q1, U0, S) - T > u]$
- $Y(Q0, Q1, U0, S) = Y^*(Q0, Q1, U0, S) + u$
- $P(Y) = [1 + e - [Yi - Ti]] - 1$
- $Yi^* = Xi'B$

Smith (1993)

- pointed out that CVM can provide a reasonable valuation of public goods or environmental goods

Mitchell and Carson (1989) and Hutchinson et al. (1995)

- pointed out that if the questionnaire designed properly, CVM is a reliable valuation method.

CVM - Questionnaire and Sampling Design

Hypothetical scenario
Assuming Taiwan's paddy field area decreases by 11% due to rice farmers' failure to compete with imported rice, there will be an average increase of 1℃ in Taiwan's suburbs in summer.

Return to

Current Situation
＊The paddy field area is 254,000 hectares. Take Taipei's suburbs for instance, the average temperature in summer is**29.4 ℃**

Bid price → Bid function → WTP

Hypothetical question of Bid price ：

- "If Taiwan's paddy field area decreases by 11% due to rice farmers' failure to compete with imported rice, which results in an average increase of 1°C in Taiwan's suburbs in summer, if every kilogram of Taiwan rice is $_____ more expensive than imported rice that has the same quality as Taiwan rice, will you be willing to continue buying local rice so that the regional temperature can be decreased by 1℃ to return to the current standard? (The current average price is provided to respondents for reference).

- For price inquiry in amounts, 15 amounts ($____) were set

In the last part of the questionnaire, the socioeconomic variables of the respondents were inquired to facilitate data analysis.

Hypothetical Situation Questionnaire Code	Hypothetical Situation (How Much More Expensive in Dollars)	No. of Questionnaire Copies Recovered	WTP Ratio
A	1	12	83%
B	2	11	91%
C	3	13	92%
D	5	12	100%
E	6	10	100%
F	7	14	86%
G	10	7	71%
H	12	16	69%
I	15	13	100%
J	20	11	91%
K	50	6	83%
L	150	19	47%
M	300	7	57%

Sampling Design and questionnaire return rate

Targets of Distribution	Government	Academia	All Questionnaires
Dates of questionnaire distribution	2010/08/23	2010/08/23 2010/09/15	2010/09/15
No. of copies distributed	150	132	282
Date of recovery	2010/09/15	2010/09/15 2010/09/17	2010/09/17
No. of copies recovered	80	71	151
Ratio of questionnaire recovery (%)	53.3%	53.7%	53.5%
No. of valid questionnaire copies	-	-	145
Valid questionnaire recovery rate (%)	-	-	51.42%

The Empirical Results

The Empirical Results of the LOGIT Model		Coefficient	Standard Deviation	T Value	P Value
Intercept	ONE	0.331107	0.994749	0.332854	0.739244
Bid Price	PRICE_DI	-0.00927	0.002712	-3.41849	0.00063
Information	KNOW	0.116233	0.04921	2.36197	0.018178
Gender	GENDER	-0.55573	0.60415	-0.91986	0.357649
No. of people in household	HOME_NUM	0.153417	0.143974	1.06559	0.286609
Area of residence	RESIDENC	0.191724	0.166258	1.15317	0.24884

Correct prediction = actual 1s and 0s correctly predicted   87.407%

WTP=249NTD/kg rice

The economic value of the heat sink effectiveness

Valuation = WTP * H * R * E

Whereas,

▶ V: Benefits of the regional paddy heat sink; unit: NTD

▶ WTP: The price respondents are willing to pay in order to prevent the temperature increase of 1°C. According to the empirical results in this survey study, the respondents are willing to pay NTD249 per kilogram of rice every year.

▶ H: The number of households in the region affected.

▶ R: The average kilograms of rice consumed by every household every year.

▶ E: The number of people per household.

The Economic Value of Paddy Heat Sink Effectiveness in Central and Southern Taiwan

Economic Value / Region	The value of mitigated temperatures in paddy field areas[1] (10^6NT\$)			
	2005	2006	2007	2008
Changhua Area (Changhua City)	807.66	809.10	812.02	834.79
Chiayi Area (Chiayi City)	1,065.06	1,069.22	1,076.39	1,114.11
Tainan area (Tainan City)	3,029.66	3,024.19	3,037.70	3,130.34
[1] The economic value for the temperature decrease of 1°C.				

The WTP for the Decrease of 1°C in the regional microclimate in Taiwan

WTP (NT$)	Number of Households in Taiwan in 2015[1] (Household)	Average Rice Consumed by Every Household Every Year[2] (Kilogram)	Average Number of People Per Household[3] (Person)	Economic Value (NT$)
249	8,419,246	48.6	2.79	2.84258E+11 (284 billion)

Conclusion

It was found that the public's total economic value for the temperature decrease of 1°C in the regional microclimate amounted to approximately NTD284 billion, thus indicating the general public's great concern for the issue of rising temperatures.

In conclusion, it need to be more cautious while making decisions in changing paddy fields to other land uses.

Thank you!!!