

Cool Forests at risk?

The critical role of boreal and mountain ecosystems for people, bioeconomy, and climate
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Assessing the Payment of Ecosystem Services of Forests in Taiwan

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OUTLINE

- Introduction
- Methodology
- Result
- Conclusion



INTRODUCTION

In the recent decade, climate changing and the extreme climate events have serious impact on earth. The **increasing extreme climate events**, which occurring in many countries, have **raised the attention on environmental issues**, including adaptation and mitigation methods. Based on the economic concept, the concept of **Payment of Ecosystem Services (PES)** are broadly implied in many countries' **environmental policies**, including natural resources conservation, land-use changing encouragement and so on. **Forests**, which provide numerous ecosystem services, is one of the significant aim in the PES policy in many countries.



Ecosystem Services



INTRODUCTION

According to the Economics of Ecosystems and Biodiversity (TEEB) in 2010, there are 17 categories for the ecosystem service. For Taiwan, among the 17 categories, **biodiversity, pest disease prevention and carbon storage**, which provide by the forests, are the three that raise the public attention.

Biodiversity: Taiwan has high biodiversity owing to the position in the middle of East Asia in which has tropical and subtropical climate and the extreme vertical altitude in geography.

Pest disease prevention: Located in the tropical and subtropical climate, Taiwan is facing increasing pest disease that cause by the climate change. Therefore the prevention of the pest is one of the important ecosystem service provided by the forest.

Carbon Storage: Because of the climate changing, the carbon storage of the forest have been more and more important nowadays.



INTRODUCTION

The **Land-use changing** is an significant problem nowadays in the in Taiwan as well.

(1) **The high density population**: Taiwan has approximately 23,570,000 population and the area around 36,000 km².

(2) **The steep geography characteristic**: Taiwan has over 70% mountain area and 268 mountains and their altitudes are over 3,000m.

(3) **Increasing climate events**: Taiwan, located in south-east Asia, is also serious influenced by extreme climate events. including Typhoon, heavy raining, and drought.

Although Taiwan did not have the forest land-use changing policy based on the PES concept so far, there are few policies applying now, including **Areca land retirement and afforestation policy and afforestation reward policy**.



INTRODUCTION

Areca land retirement and afforestation policy

Areca catechu, as known as Betel nuts in Taiwan, is kind of fruit in local. During to the traditional and cultural reasons, **there are many consumers in Taiwan**. Owing to the benefit of Betel business, there are many Areca garden in Taiwan. However, according to the previous studies, the ***Areca catechu* is not a good species for soil and water container in the steep slope area**. Therefore, government would like to **encourage the landowner to transform the *Areca catechu* into the native tree species** plantaion. The Areca land retirement and afforestation policy would aim to reduce the area of Areca land. Yet **the consequence is not very effective**.



Picture reference: <https://edition.cnn.com/2016/09/05/asia/taiwan-asia-betel-nuts/index.html>

INTRODUCTION

Afforestation reward policy

The **steep slope of the mountain** and the **heavy rain** in Taiwan make the forest an significant natural resource. Forests not only provide the environmental conservation but also provide carbon storage and recreation function. Therefore, the government would **provide the reward to encourage afforestation in Taiwan** after 1980s. The policy aim to **increase the area of afforestation on bared land and fallow land**. Although the reward is very high in Taiwan, **the result of the policy is not very effective**. Therefore, the government is eager for any information that could improve this policy.



<http://news.ltn.com.tw/news/life/breakingnews/1318655>



<http://ourisland.pts.org.tw/content/%E5%B1%85%E5%B1%B1%E6%80%9D%E5%8D%B1>

INTRODUCTION

In order to solve the problem that the government faced, our study would **assess the optimum forest land-use changing payment of ecosystem services**. Basing on the Areca garden retirement and afforestation policy and Afforestation reward policy, our research would use **the Areca land, bared land and fallow land** as the research area and calculate the payment of ecosystem services **of biodiversity, pest disease prevention, and the carbon storage**.

Our goals:

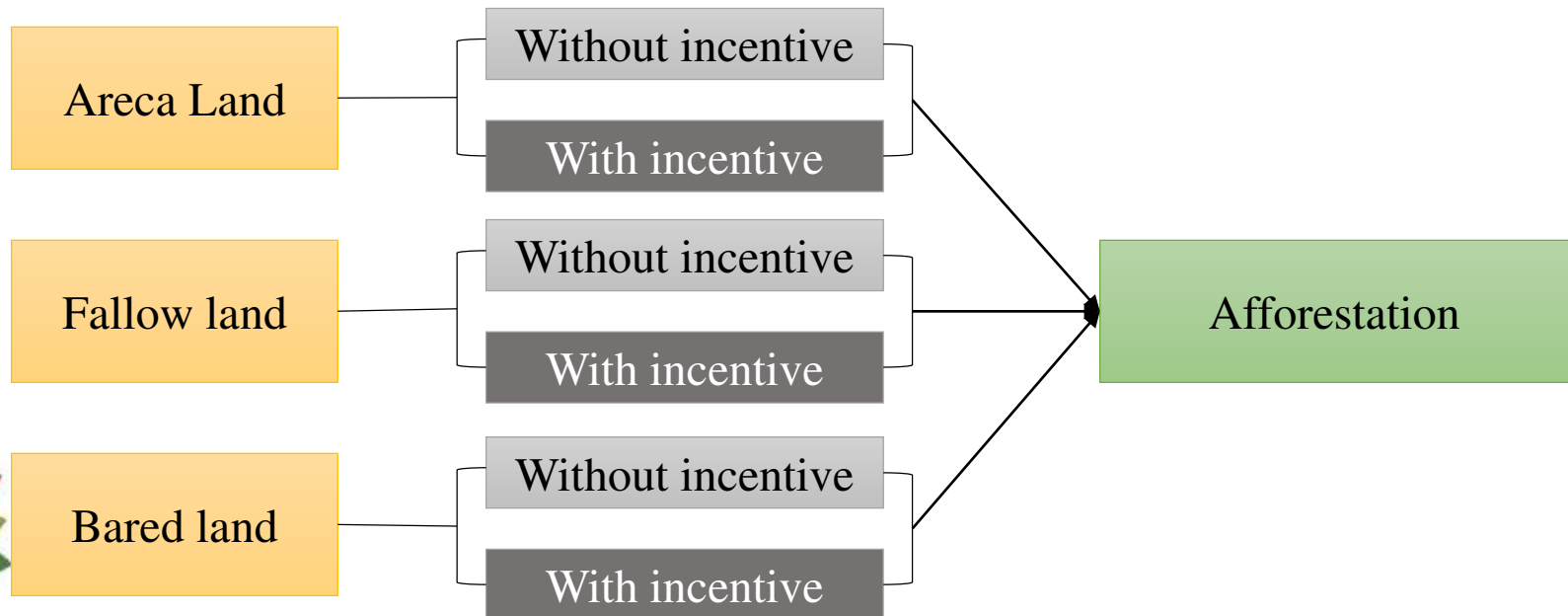
1. Use Choice Experiment (CE) to assess the upper limit optimum forest payment of ecosystem services for biodiversity, pest disease prevention, and the carbon storage under the transformation scenarios from Areca land, fallow land and bared land.

2. Analyze the influence of the environmental attitude and the socio-demography on the optimum forest payment of ecosystem services.












Methodology

Choice Experiment (CE) is originated from Lancaster's consumer theory, which states that the **utility of a commodity** is the total sum of utilities of all its attributes (Lancaster, 1966). In the theory, **each attribute of a commodity affects respondents' choice**. Compared with the Contingent Valuation Method (CVM), CE could calculate the different attribute's value while the CVM could only calculate the whole commodity's ones.



Methodology

Attribute	Description	Level
Increase biodiversity	Changing the biodiversity by planning different native species.	0*, 1, 3, 5
Reduce the pest disease	The afforestation could reduce the pest disease.	0*, 10%, 20%, 30%
Carbon storage	Different species would have different carbon storage ability.	0*, 10%, 20%, 30%

Scenario 1			
Attributes	SQ	Alternative 1	Alternative 2
Increase biodiversity	Areca garden 	One native species 	One native species 
Reduce the pest disease	0 	-10% 	0 
Carbon Storage	Few 	+30% 	+10% 
Price of incentive for the land use changing	0·NTD	500·NTD	300·NTD
Choice one	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



RESULT Descriptive Analysis

The questionnaires were delivered via internet from June, 2018 to August, 2018.

The number of the deliver questionnaires: 440

The number of the valid questionnaires: 424

Socio-demography	Category	number	%
Gender (GEN)	Female	230	54.2
	Male	194	45.8
Married (MAR)	Unmarried	336	79.2
	Married	88	20.8
Education level (EDU)	Junior high school and below	2	0.5
	Senior high school	26	6.1
	Undergraduate	258	60.8
	Graduate	138	32.5
Did you attend any environmental education courses or training? (EEDU)	No	208	49.1
	Yes	216	50.9
Resident (RES)	North	166	39.2
	Middle	150	35.4
	South	93	21.9
	East	12	2.8
	Offshored	3	0.7
Occupation	Agriculture	40	9.4
	Industry	30	7.1
	Services industry	77	18.2
	Government officer/military	63	14.9
	Retired	5	1.2
	Housekeeper	10	2.4
	Student	134	31.6
	Free lancer	61	14.4
	Other	4	0.9
Have you heard about Payment of Ecosystem Services? (PES)	No	328	77.4
	Yes	96	22.6



RESULT Descriptive Analysis

Environmental Attitude (EA)

Environmental Attitude		Cronbach's alpha.		
Total		0.726		
Category	Question	Average	SD	Total
Limits to growth (LTG)	We are approaching the limit of the number of people the Earth can support.	4.14	0.85	11.11
	The Earth has plenty of natural resources if we just learn how to develop them.	2.82	1.22	
	The Earth is like a spaceship with very limited room and resources.	4.16	0.92	
Anti-anthropocentrism (ANA)	Humans have the right to modify the natural environment to suit their needs.	3.34	1.25	11.92
	Plants and animals have as much right as humans to exist.	4.38	0.82	
	Humans were meant to rule over the rest of nature.	4.20	0.93	
Balance of nature (BN)	When humans interfere with nature it often produces disastrous consequences.	3.20	1.10	10.91
	The balance of nature is strong enough to cope with the impacts of modern industrial nations.	3.91	1.03	
	The balance of nature is very delicate and easily upset.	3.80	1.06	
Rejection of exemptionalism (RE)	Human ingenuity will insure that we do not make the Earth unlivable.	2.75	1.17	10.70
	Despite our special abilities, humans are still subject to the laws of nature.	4.39	0.78	
	Humans will eventually learn enough about how nature works to be able to control it	3.55	1.13	
Possibility of an ecocrisis (POE)	Humans are seriously abusing the environment.	4.53	0.68	12.64
	The so-called "ecological crisis" facing humankind has been greatly exaggerated.	3.78	1.10	
	If things continue on their present course, we will soon experience a major ecological catastrophe.	4.33	0.83	

RESULT

Correlation Analysis

Category		GENDER	MAR	AGE	EDU	EEDU	RES	INCOME	OPP	PES
EA	LTG	-0.073	0.065	0.130**	-0.019	0.030	0.075	0.057	-0.034	0.069
	ANA	-0.203***	-0.069	-0.023	-0.052	0.047	0.029	-0.028	0.045	0.005
	BN	-0.103*	0.088	0.123*	-0.042	-0.039	0.044	0.324	0.179	0.271
	RE	-0.125**	0.082	0.077	-0.103*	0.019	0.069	-0.018	0.044	-0.039
	POE	-0.049	0.026	0.078	-0.048	0.039	0.058	-0.048	0.048	0.038

Areca land

without government incentive

	CS1	CS2	CS3	CS4	CS5	CS6
LTG	-0.017	0.065	0.132**	0.036	0.097*	-0.017
ANA	-0.034	0.106*	0.136**	0.122*	0.164***	0.000
BN	-0.052	0.128**	0.140**	0.104*	0.113*	-0.037
RE	0.041	0.058	0.038	0.029	0.052	-0.100*
POE	-1.000*	0.144**	0.139**	0.140**	0.169***	-0.131**

with government incentive

	CS7	CS8	CS9	CS10	CS11	CS12
LTG	0.006	0.090	0.144**	0.089	0.075	0.021
ANA	-0.091	0.108*	0.128**	0.150**	0.151**	-0.097*
BN	-0.061	0.106*	0.126**	0.114*	0.108*	-0.097*
RE	-0.016	0.051	0.060	0.072	0.092	0.011
POE	-200***	0.188***	0.119*	0.223***	0.146**	-0.093

The score of possibility of an ecocrisis (POE), anti-anthropocentrism (ANA), and balance of nature (BN) have significant correlation with the respondents' decision.

RESULT

Correlation Analysis

Bared Land

without government incentive

	CS13	CS14	CS15	CS16	CS17	CS18
LTG	-0.030	0.114*	0.104*	0.171***	0.132**	-0.026
ANA	-0.020	0.122*	0.148**	0.171***	0.151**	-0.008
BN	-0.022	0.142**	0.137**	0.186***	0.174***	-0.032
RE	0.038	0.068	0.102*	0.079	0.129**	0.006
POE	-0.039	0.165***	0.179***	0.197***	0.153**	-0.076

with government incentive

	CS19	CS20	CS21	CS22	CS23	CS24
LTG	0.018	0.056	0.053	0.098*	0.050	-0.094
ANA	-0.031	0.171***	0.121*	0.188***	0.177***	-0.144**
BN	0.007	0.159***	0.122*	0.218***	0.136**	-0.177***
RE	-0.023	0.112*	0.094	0.068	0.098*	-0.067
POE	-0.058	0.192***	0.161***	0.198***	0.235***	-0.179***

- The score of limit to growth (LTG) would have significant influence under the scenarios without incentive.
- The score of possibility of an ecocrisis (POE), anti-anthropocentrism (ANA), balance of nature (BN) have significant correlation with the respondents' decision.



RESULT

Correlation Analysis

Fallow Land

without government incentive

	CS25	CS26	CS27	CS28	CS29	CS30
LTG	0.010	0.101*	0.126**	0.101*	0.110*	-0.016
ANA	-0.024	0.129**	0.154***	0.139**	0.153**	0.005
BN	-0.002	0.070	0.154***	0.135**	0.129**	-0.024
RE	0.059	0.071	0.117*	0.031	0.089	0.029
POE	-0.046	0.137**	0.155***	0.130**	0.176***	-0.034

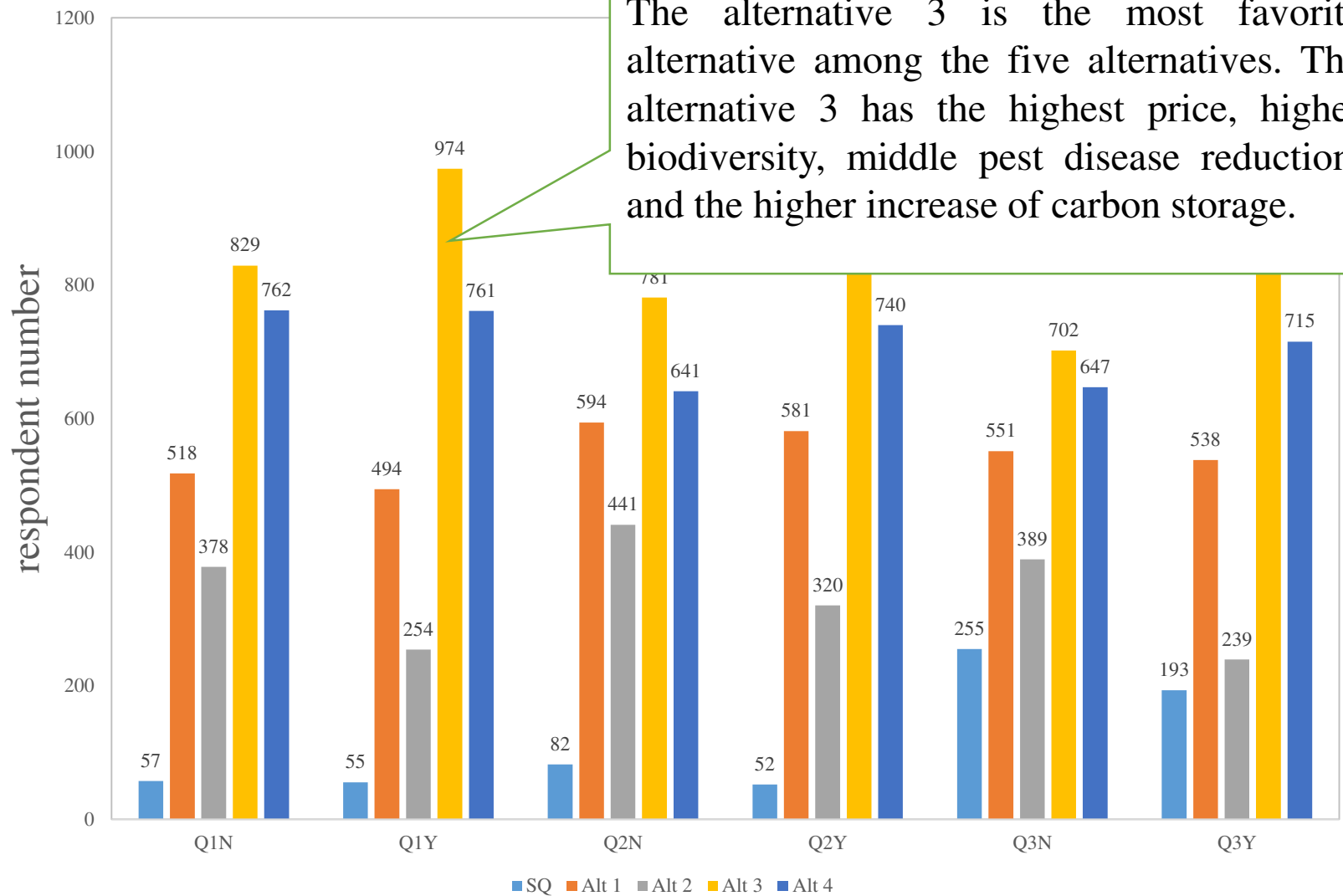
With government incentive

	CS31	CS32	CS33	CS34	CS35	CS36
LTG	0.088	0.075	0.075	0.109*	0.166***	-0.017
ANA	0.013	0.083	0.070	0.129**	0.166***	0.014
BN	0.087	0.074	0.117*	0.134**	0.172***	0.013
RE	0.005	0.135**	0.137**	0.072	0.112*	-0.055
POE	-0.006	0.147**	0.147**	0.168	0.207***	-0.044

- The score of limit to growth (LTG) would have significant influence under the scenarios without incentive; The score of rejection of exemptionalism (RE) would have significant influence under the scenarios with incentive.
- The score of possibility of an ecocrisis (POE), anti-anthropocentrism (ANA), and balance of nature (BN) have significant correlation with the respondents' decision.

RESULT

The result of the different scenarios

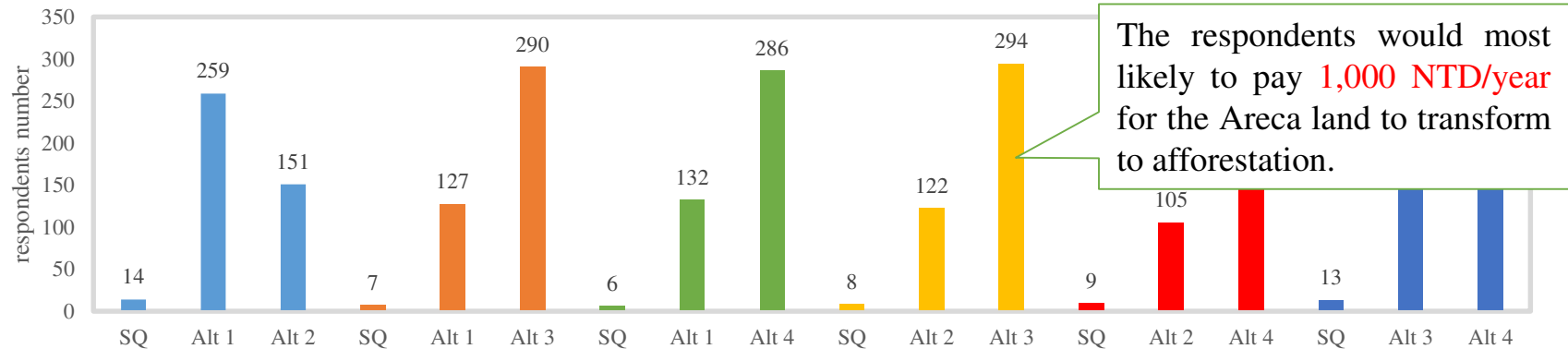


RESULT

The result of the different scenarios

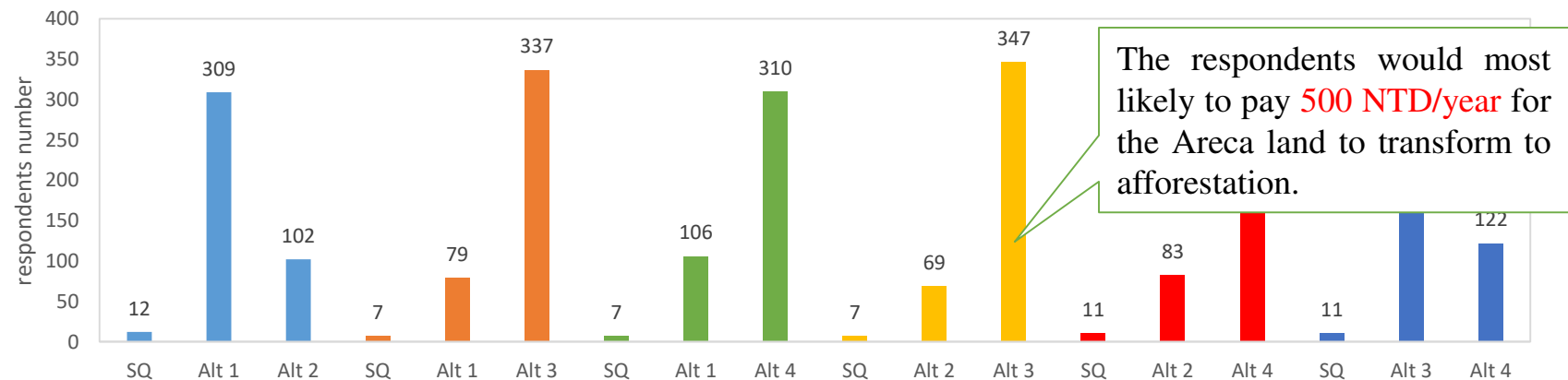
Areca land

without government incentive



The respondents would most likely to pay **1,000 NTD/year** for the Areca land to transform to afforestation.

with government incentive



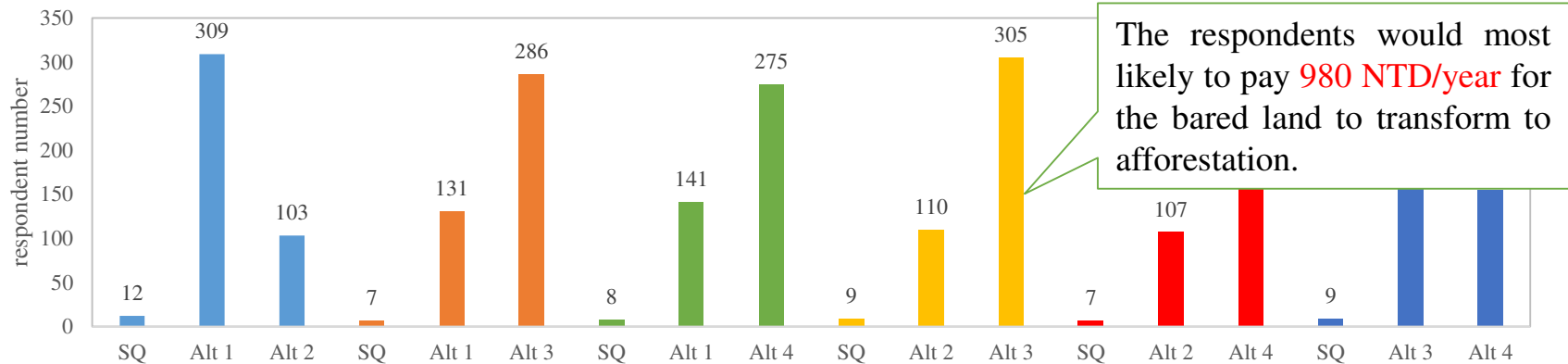
The respondents would most likely to pay **500 NTD/year** for the Areca land to transform to afforestation.

RESULT

The result of the different scenarios

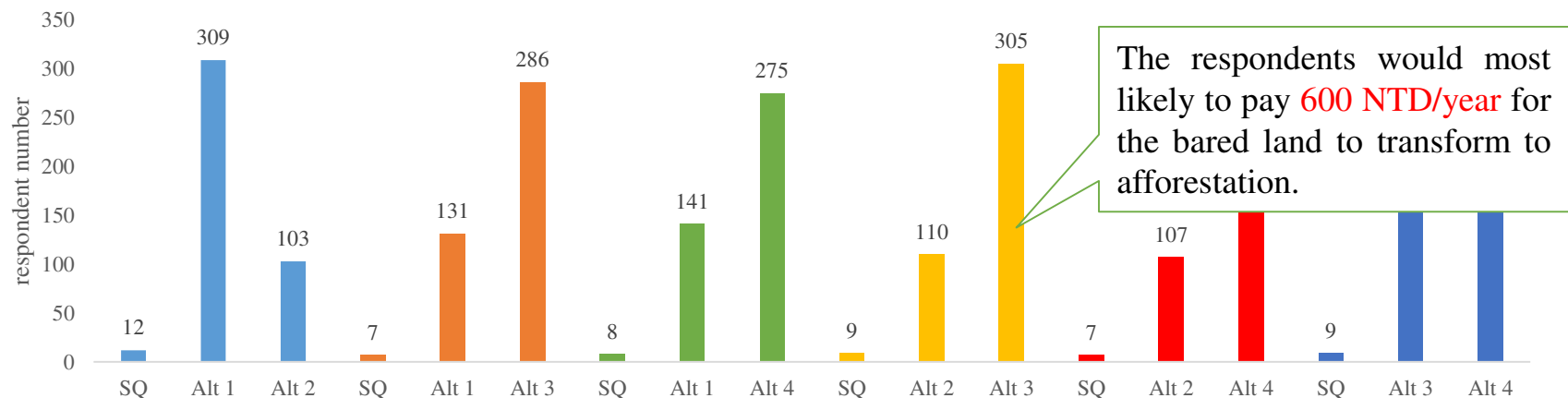
Bared Land

without government incentive



The respondents would most likely to pay **980 NTD/year** for the bared land to transform to afforestation.

with government incentive



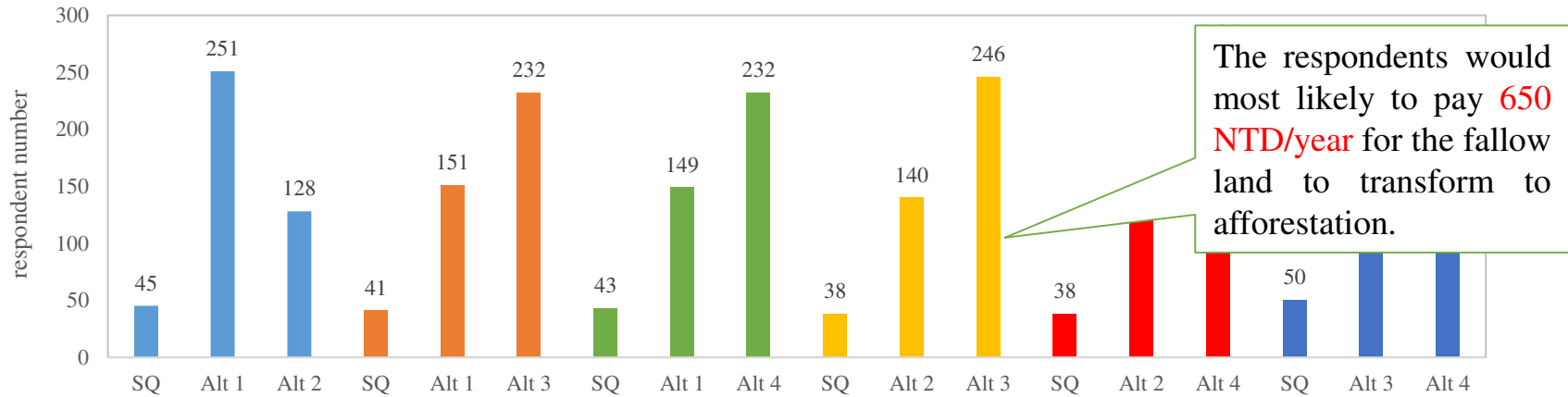
The respondents would most likely to pay **600 NTD/year** for the bared land to transform to afforestation.

RESULT

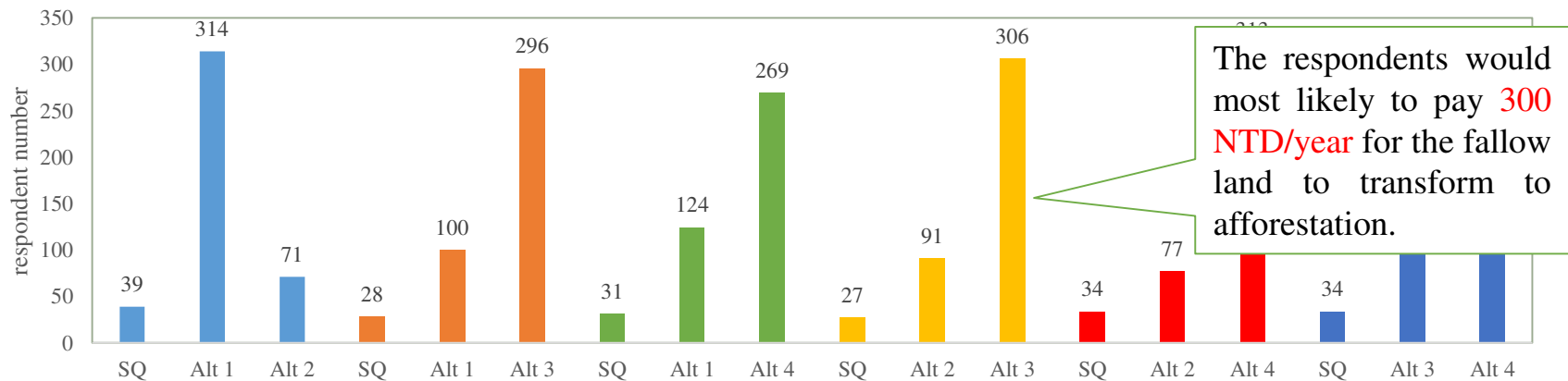
The result of the different scenarios

Fallow Land

without government incentive



with incentive



CONCLUSION

1. Use Choice Experiment to assess the upper limit optimum forest payment of ecosystem services for biodiversity, pest prevention, and the carbon storage under the transformation scenarios from Areca land, bared land and fallow land.

Land type	With/Without government incentive	WTP (NTD/person)	WTP (NTD/year)
Areca land	Without	1,000	23,557,271,000
	With	500	11,778,635,500
Bared land	Without	980	23,086,125,580
	With	600	14,134,362,600
Fallow land	Without	650	15,312,226,150
	With	300	7,067,181,300



CONCLUSION

2. Analyze the influence of the environmental attitude and the socio-demography on the optimum forest payment of ecosystem services.

Land type	Government incentive	The significant influence of environmental attitude Categories
Areca land	With/without	possibility of an ecocrisis (POE), anti-anthropocentrism (ANA), balance of nature (BN)
Bared land	Without	limit to growth (LTG), Possibility of an ecocrisis (POE), anti-anthropocentrism (ANA), balance of nature (BN)
	With	possibility of an ecocrisis (POE), anti-anthropocentrism (ANA), balance of nature (BN)
Fallow land	Without	limit to growth (LTG), possibility of an ecocrisis (POE), anti-anthropocentrism (ANA), balance of nature (BN)
	With	rejection of exemptionalism (RE), possibility of an ecocrisis (POE), anti-anthropocentrism (ANA), balance of nature (BN)





Thanks for your attention

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APPENDIX—ecosystem service

BIODIVERSITY ECOSERVICES

Living Planet and Human Well-Being



PROVISIONING
Food



PROVISIONING
Raw Materials



REGULATING
Natural Disasters



REGULATING
Pollination



CULTURE
Tourism



PROVISIONING
Fresh Water



PROVISIONING
Medicinal Resources



REGULATING
Waste-Water Treatment



REGULATING
Biological Control



CULTURE
Recreation and Health



REGULATING
Local Climate



REGULATING
Carbon Storage



REGULATING
Erosion and Fertility



HABITAT
Species and Ecosystems



HABITAT
Genetic Diversity



CULTURE
Spiritual Experience



CULTURE
Aesthetic Appreciation

Icons: Jan Sasse / TEEB
Design: Globaia



APPENDIX—Questionnaire

同意編號：..... 調查日期： ____年__月__日， ____時__分(24小時制)

第一部分：基本資料

1. 請問您的性別為何：男 女
2. 請問您的婚姻狀況為何：已婚 未婚
3. 請問您的年齡為何：20歲以下 21-25歲 26-30歲 31-35歲 36-40歲 41-45歲 46-50歲 51-55歲 56-60歲 61-65歲 66-70歲 71-75歲 75歲以上
4. 請問您的教育程度為何：國十(含以下) 國十(含以上) 大學(部) 碩士(含以上)
5. 請問您的職業為何：無固定職業 公務 服務業 專業技術人員 漁業人員 農林 其他
自由業 其他
6. 請問您是否曾參加過學校教育或自然環境綜合課程的課程：是 否
7. 請問您的居住處： (縣市)
8. 請問您個人月所得為何：2萬元以下 2萬到4萬元 4萬到6萬元 6萬到8萬元 8萬到10萬元 10萬到12萬元 12萬到14萬元 14萬到16萬元 16萬到18萬元 18萬元以上
9. 請問您是否曾支付過生態服務費的給付 (Payment of Ecosystem Services)?
是 否

第二部分：環境態度

請對下列所述的敘述，請您根據自身的感受進行標率，請您說明是「完全」選擇何種敘述的標率。

題目	完全 同意 標	同 意 標	中 性 標	不 同 意 標	完全 不 同 意 標
1.→人類的社會組織比環境可以支撐的規模。					
2.→人類發展為了自己的利益而破壞大自然環境。					
3.→人類應該採取限制資源。					
4.→動植物與人類有平等的發展權利。					
5.→人類應提高森林採集力，從而創造不同類別的生態。					
6.→人類發展應與自然環境以和諧發展。					
7.→人類的發展可由傳統環境令人類居住。					
8.→生態環境的學習和開發利用，環境的資源是十分充裕的。					
9.→自然界的平衡機制可以承受人類活動所說成的影響。					
10.→我們的目標是為了發展生態。					
11.→人類及其他生物力量都來自自然。					
12.→人類應尊重與大自然的關係並加以控制它。					
13.→環境發展是一股平衡且資源都有限制的本質。					
14.→大自然應與人類發展是息息相關。					
15.→森林環境的發展是經濟，政府應快將資源劃一場次開發。					

第五部分：生態服務費的選擇方案

請您根據目前山上現狀以及假設兩種開發方案的目的，進而為了成本選擇，您最多能選擇目的，且會比較環境的損壞程度與開發設施，並從目前二種方案中選擇。合則在不少環境成本，本研究的目的為了瞭解民眾對於生態服務的價值下，願意支付生態服務費的價值，請您對目前環境社會，您對目前環境上開發，改善環境社會中，**成本選擇以開發環境為最佳。**

圖：成本選擇以開發環境為最佳。

環境開發方案	開發成本		
	方案一	方案二	方案三
環境開發方案	方案一 	方案二 	方案三 
減少污染等標率	高 	中 	低 
碳排降低量	少 	中 	多 
每人每年支付(人民幣/年)	0元	100元	100元
您是否願意支付標率	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

環境開發方案	開發成本		
	方案一	方案二	方案三
環境開發方案	方案一 	方案二 	方案三 
減少污染等標率	高 	中 	低 
碳排降低量	少 	中 	多 
每人每年支付(人民幣/年)	0元	100元	1000元
您是否願意支付標率	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>