CHAPTER 5

NORMALIZATION AND WEIGHTING FACTORS

5.1 Scope and system boundary of weighting factors

The framework and scope of weighing factors to aggregate the results into a single score is shown in Figure 5.1. The current study was undertaken to investigate Willingness–to–Pay (WTP) for decreased damage to human health, social assets, biodiversity, and primary production. The data were collected from a random sample of four groups of residential areas in Thailand (Figure 5.2). Those who lived in Bangkok Metropolis, Phitsanulok, Samut Prakan, Rayong, and Chonburi are represented as the group 1 sample; Chiang Mai, Phayao, and Lampang are represented in group 2; Songkhla, Nakhon Si Thammarat, Phatthalung, Narathiwat, Chumphon, and Kanchanaburi are represented in group 3; Nakhon Ratchasima, Khon Kaen, Loei, Ubon Ratchathani, and Maha Sarakham are represented in group 4. A total of 418 survey questionnaires were randomly chosen through a systematic sampling of individuals. The surveys were conducted face–to–face with the interviewee using bidding game questions. The time period for data collection was during August 2012–April 2013.

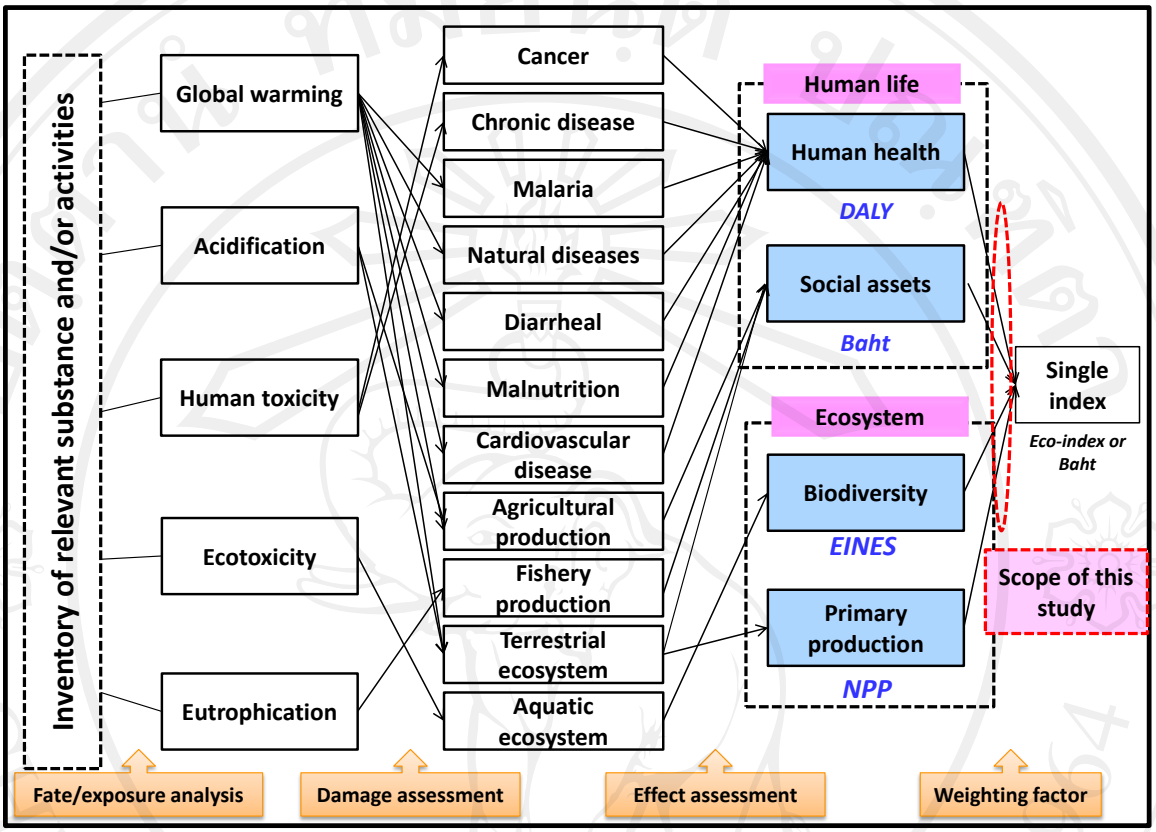

Figure 5.1: The framework and scope of weighting factors

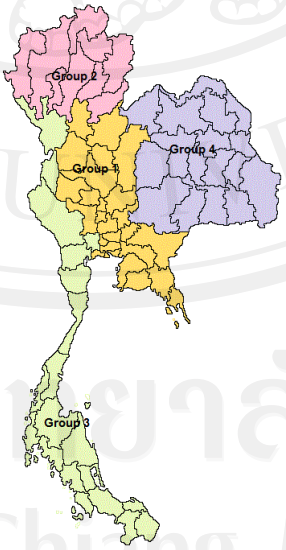

Figure 5.2: The system boundary of the area of residence for data collection

5.2 Questionnaire structure

The questionnaire (see in Appendix C) consisted of three sections, outlined in Table 5.1. Section 1 is divided into two parts – general knowledge and general opinion. The first part inquired into the Life Cycle Assessment (LCA) and Life Cycle Impact Assessment (LCIA) knowledge of the respondent. The interviewer explained LCA and LCIA to respondents if they had no knowledge of it. The second part gave information about loss of human health, social assets, biodiversity, and primary production. Then, asked respondents about the importance of their loss. Section 2 highlighted the hypothetical scenario on better to be valued if environmental improvement. For the last section, questions on socio–economic information such as age, gender, education, income, knowledge of environment fields, etc., were posed. This information was necessary to determine the factors affecting WTP and would also allow an estimation of population statistics.

Table 5.1: Outline of the survey questionnaire, consisting of three sections

Section	Title
Section 1	General knowledge and opinion
Section 2	Willingness–to–Pay for natural management fund
Section 3	Socio–economic information

5.3 Bid price determination

Pretests were done to assist with the selection of the final bid amount. Open–ended questions were used in the pretest activities. From the pretest activities, four feasible bid amounts were determined and used in the survey proper. These were 100, 200, 500, and 1000 Baht.

5.4 Elicitation method

The valuation question was posed by asking respondents a referendum question which inquired if they were willing or not willing to vote for management of natural resources that would require payment of a fee. This is the technique used in this study.

To conduct this study a Dichotomous Choice (DC) referendum format was adopted. This referendum format is recommended by the National Oceanic and Atmospheric Administration (NOAA) panel (Arrow *et al*., 1993) since it has the advantage of being incentive compatible.[1] In particular, this study used single–bounded DC[1] by asking if respondents would vote for the proposed management of natural resources, which would require them to pay a surcharge on their annual tax.

5.5 Hypothesized scenario

The management of natural resources scenarios in section 2 consisted of three parts. In part A, the current human health, social assets, biodiversity, and primary production damage due to environmental problems was presented to ensure respondents had equal levels of knowledge on the non–market good to be valued. In this section, the effects on human health, natural resources, biodiversity, and primary production due to environmental problems were presented. The existing and future threats to the environment were also explained. Moreover, future development plans that would increase threats to the environment were also described. Part B detailed the proposed management of natural resources, and the short and long term effects of these activities were explained. In the final part, the contingent valuation question of whether the respondent is willing or not willing to support the project was included.

5.6 Variable analysis

Analysis was done using independent and dependent variables estimation framework to estimated WTP. The details are follows:

5.6.1 Dependent variables

An individual willingness to pay for decreased loss of each area – human health, social assets, biodiversity, and primary production.

[1] DC format, respondents respond "yes" if he or she is willing to purchase the good or service and "no" otherwise. (Bateman *et al*., 2002)

5.6.2 Independent variables

- Population sample of 418 people separated into four groups–(1) central and eastern, (2) northern, (3) north-eastern, and (4) west and southern Thailand.

- Background and knowledge such as LCA, LCIA, impact category, and environmental problems in Thailand.

- Personal data, such as gender, age, education level, individual income, religion, marital status, residual area, etc.

- Motivation factors, such as environmental concern for Thailand and attitude toward environmental damage to human health, social assets, biodiversity, and primary production, and the effect on people.

5.7 Hypothesized effects of variables on WTP

In the variable analysis, the independent variables used in the multivariate probit regression, their definition, and hypothesized directions of effects on respondent's WTP are summarized in Table 5.2.

The bid price (WTPBID) is expected to negatively affect WTP. This is supported by the economic theory that as prices increase the demand for the good, or the WTP for effects on human health, social assets, biodiversity, and primary production, decreased.

Various socio–economic variables are predicted to influence WTP indifference directions. For gender (GENDER) and marital status (MARRIED) an effect is sometimes found, although a priori there is no expectation on the direction of an effect. The other socio–economic variables indicate respondents' ability/inability to pay. Those who can afford more would be willing to pay a higher amount. Individual monthly income (INCOME) and education level (EDUCAT) impress a positive effect on WTP since they indicate a higher ability to pay. Finally, age (AGE) and expert (EXPERT) could have both positive and negative effects depending on how they value future use.

Table 5.2: Definition of variables

Variable name	Variable description	Direction of effects
WTPBID	Bid amount (1 = 100 Baht, 2 = 200 Baht, 3 = 500 Baht, 4 = 1,000 Baht)	–
GENDER	Respondent's gender (1 = male, 2 = female)	?
MARRIED	Respondent's marital status (1= single, 2 = otherwise)	?
INCOME	Respondent's monthly income	+
EDUCAT	Respondent's education level	+
AGE	Respondent's age	+/–
EXPERT	Respondent's knowledge of LCA and LCIA	+/–

5.8 Results and discussion

This section provides the summary of the socio–economic characteristics of the sample respondents (detailed in Appendix F). It also includes information such as environmental concerns in Thailand, and attitudes about the effect of environmental damage on human health, social assets, biodiversity, and primary production. Statistical averages and frequencies were computed using Stata (Lopez–Feldman, 2012).

5.8.1 Socio–economic profile

Table 5.3 presents a general profile of the respondents. The average age is 39.76 year old. They are female, single, and hold a bachelor degree or equivalent level of education. Respondents from the whole of Thailand averaged a monthly individual income of 32,465 Baht/person. It should be noted that most respondents worked at a government institution or a company and earned a high income.

Table 5.3: Socio–economic profile of sample respondents

Indicator	Number	Average	Median	S.D.	Percentage
Age[1]	–	39.76	46.19	10.90	–
Gender: Female	212	–	–	–	50.72
Marital status: Single	273	–	–	–	65.31
Education level: Bachelor degree or equivalent	195	–	–	–	46.65
Total monthly income[2]	–	32,465	31,353	27,352	–
Total number of respondents	418	–	–	–	–

Remark: [1]Life expectancy assumed to be 73.8 years old (NSO, 2011)
[2]Maximum income assumed to be 200,000 Baht

5.8.2 Problems in Thailand

From the analysis of personal data about problems in Thailand from the sample in Table 5.4, it was found that out of 12 choices 73 samples, which is 17.46%, thought that economic problems are the main concern in Thailand. There were 33 samples, which is 7.89%, who chose the problem of poverty; 16 samples chose the problem of drug trafficking; 93 samples chose the problem of education; 3 samples chose the problem of public health; 10 samples chose the problem of crime and violence; 120 samples chose the problem of politics; 31 samples chose the problem of infrastructure, such as roads and water supply; 34 samples chose the problem of environment and disasters; 5 samples chose the problem of political unrest, such as red shirt and yellow shirt protests. However, the interviewees thought that both the unrest in the three southern border provinces and international trade issues were not the main problems in Thailand.

Table 5.4: Problems in Thailand

Environmental concerns/group	Group 1	Group 2	Group 3	Group 4	Total	
					Number	%
(1) Economic problems(such as, inflation, unemployment)	22	15	14	22	73	17.46
(2) Problem of poverty	7	9	8	9	33	7.89
(3) Problem of drug trafficking	5	1	8	2	16	3.83
(4) Problem of education	20	21	30	22	93	22.25
(5) Problem of public health	0	2	0	1	3	0.72
(6) Problem of crime and violence	3	2	2	3	10	2.39
(7) Problem of politics (such as corruption)	34	34	25	27	120	28.71
(8) Problem of infrastructure (such as roads, water supply)	6	9	8	8	31	7.42
(9) Problem of environment and disasters	7	8	10	9	34	8.13
(10) The unrest in the three southern border provinces	0	0	0	0	0	0
(11) International trade issues (trade liberalization between FTA)	0	0	0	0	0	0
(12) The political unrest (red shirt, yellow shirt)	1	3	0	1	5	1.20

5.8.3 Environmental concerns in Thailand

From the analysis of motivational factors behind environmental concern in Thailand from the sample in Table 5.5, it was found that from 14 choices of environmental concerns in Thailand 93 samples, which is 22.25%, thought that the biggest environmental concern is global warming. The environmental concern of land use was chosen by 83 samples, which is 19.86%; 46 (11%) samples chose human toxicity; 39 (9.33%) samples chose photochemical oxidation; 36 (8.61) samples chose waste; 34 (8.13%) samples chose urban air pollutants; 26 (6.22%) samples chose ecotoxicity; 21 (5.02%) samples chose acidification; 17 (4.07) samples chose eutrophication; both resource depletion and noise were chosen by 8 (1.91%) samples; 5 (1.20%) samples chose ozone layer depletion, and 2 (0.48%) samples chose other damage, such as water

pollutants. However, the interviewees thought odor was not a main environmental concern in Thailand.

Table 5.5: Environmental concerns in Thailand

Environmental concerns/group	Group 1	Group 2	Group 3	Group 4	Total	
					Number	%
Acidification	2	7	5	7	21	5.02
Land use	19	18	21	25	83	19.86
Eutrophication	4	6	4	3	17	4.07
Ozone layer depletion	0	1	2	2	5	1.20
Global warming	22	21	30	20	93	22.25
Resource depletion	2	3	2	1	8	1.91
Human toxicity	12	15	10	9	46	11.00
Ecotoxicity	6	7	5	8	26	6.22
Urban air pollution	9	7	10	8	34	8.13
Waste	17	7	7	5	36	8.61
Photochemical oxidation	8	11	8	12	39	9.33
Noise	2	1	1	4	8	1.91
Odor	0	0	0	0	0	0.00
Other environmental concerns (water pollution)	2	0	0	0	2	0.48

5.8.4 Attitudes toward the effects of environmental damage on human health, social assets, biodiversity, and primary production

From the analysis of motivational factors behind attitudes toward the effects of environmental damage on human health, social assets, biodiversity, and primary production from the sample group in Table 5.6, it was found that 236 samples chose environmental damage on human health, which is 56.46%; 95 samples chose social assets, which is 22.73%; 35 samples chose biodiversity, which is 8.37%; and 52 samples chose primary production, which is 12.44%.

Table 5.6: Attitudes toward environmental damage

Group	Human health	Social assets	Biodiversity	Primary production
Group 1	65	17	11	12
Group 2	58	26	9	11
Group 3	58	23	9	15
Group 4	55	29	6	14
Total	236 (56.46)	95 (22.73)	35 (8.37)	52 (12.44)

Remark: Percentages in parentheses

5.8.5 Attitudes toward loss of safeguard subjects

The analysis of motivational factors behind attitudes toward loss of areas of safeguard from the sample in Table 5.7 was divided into four areas of safeguard – human health, social assets, biodiversity and primary production. 239 samples thought loss of human health was most important; 120 samples thought it was very important; 39 samples thought it was important; 10 samples thought it was of little importance; 13 samples thought it was insignificant, with an average of 1.67, and estimated S.D. of 0.96.

For loss of social assets, 138 samples thought it was the most important; 201 samples thought it was very important; 69 samples thought it was important; 7 samples thought it was of little importance; 3 samples thought it was insignificant, with an average of 1.89, and estimated S.D. of 0.78.

For loss of biodiversity, 199 samples thought it was the most important; 146 samples thought it was very important; 61 samples thought it was important; 12 samples thought it was of little important, with an average of 1.73, and estimated S.D. of 0.81.

For loss of primary production, 208 samples thought it was the most important; 140 samples thought it was very important; 61 samples thought it was important; 8 samples thought it was of little importance; 1 sample thought it was insignificant, with an average of 1.69, and estimated S.D. of 0.80.

Table 5.7: Attitudes toward loss of safeguard subjects

Group	Most important (1)	Very important (2)	Important (3)	Of little importance (4)	Insignificant (5)
Human health					
Group 1	60	34	6	3	2
Group 2	61	24	12	4	3
Group 3	58	32	13	1	1
Group 4	57	30	8	2	7
Total	236 (56.46)	120 (28.71)	39 (9.33)	10 (2.39)	13 (3.11)
Averaged 1.67; S.D. 0.96					
Social assets					
Group 1	36	51	17	1	0
Group 2	36	48	20	0	0
Group 3	30	55	13	5	2
Group 4	36	47	19	1	1
Total	138 (33.01)	201 (48.09)	69 (16.51)	7 (1.67)	3 (0.72)
Averaged 1.89; S.D. 0.78					
Biodiversity					
Group 1	51	39	13	2	0
Group 2	46	41	14	3	0
Group 3	55	34	12	4	0
Group 4	47	32	22	3	0
Total	199 (47.61)	146 (34.93)	61 (14.59)	12 (2.87)	0 (0.00)
Averaged 1.73; S.D. 0.81					
Primary production					
Group 1	50	35	19	1	0
Group 2	45	41	16	2	0
Group 3	59	31	14	1	0
Group 4	54	33	12	4	1
Total	208 (49.76)	140 (33.49)	61 (14.59)	8 (1.91)	1 (0.24)
Averaged 1.69; S.D. 0.80					

Remark: Percentages in parentheses

5.8.6 Attitudes toward the damage of safeguard subjects

From the analysis of motivational factors behind attitudes toward the damage of areas of safeguard from the sample in Table 5.8, it was found that an average of 7.48,

thought that damage on human health was important, with an S.D. of 1.54. Social assets averaged the important damage of 6.41, with an S.D. of 1.59; biodiversity averaged 7.39, with 1.53 for S.D. Finally, primary production averaged the important damage of 7.21, with an S.D. of 1.65.

Table 5.8: Attitudes toward damage of areas of safeguard

Group	Insignificant (1)	Least important (2)	Of little important (3)	Fairly important (4)	Important (5)	Very important (6)	Truly important (7)	Of great important (8)	Most important (9)
Human health									
Group 1	1	1	0	2	6	8	16	31	40
Group 2	0	0	0	3	6	7	27	26	33
Group 3	0	2	0	4	10	6	34	27	24
Group 4	2	1	0	4	8	6	25	30	28
Total	3 (0.72)	4 (0.96)	0 (0.00)	13 (3.11)	30 (7.18)	27 (6.46)	102 (24.20)	114 (27.27)	125 (29.90)
Averaged 7.48; S.D. 1.54									
Social assets									
Group 1	0	1	1	6	20	13	36	21	7
Group 2	0	3	2	7	18	14	27	25	8
Group 3	0	2	1	6	29	18	27	15	7
Group 4	1	4	2	2	24	17	27	19	8
Total	1 (0.24)	10 (2.39)	6 (1.44)	21 (5.02)	91 (21.77)	62 (14.83)	117 (27.99)	80 (19.44)	30 (7.18)
Averaged 6.41; S.D. 1.59									
Biodiversity									
Group 1	2	0	4	1	3	11	34	28	22
Group 2	1	0	3	2	3	5	33	37	20
Group 3	1	0	4	2	5	13	26	22	32
Group 4	0	0	3	2	3	7	34	29	26
Total	4 (0.96)	0 (0.00)	10 (2.39)	7 (1.67)	14 (6.22)	36 (8.61)	127 (30.38)	116 (27.75)	100 (23.92)
Averaged 7.39; S.D.1.53									
Primary production									
Group 1	1	2	1	1	7	8	28	28	29
Group 2	1	0	2	3	5	6	35	34	18
Group 3	2	0	0	5	8	11	26	34	19
Group 4	4	1	2	3	6	11	34	21	22
Total	8 (1.91)	3 (0.72)	5 (1.20)	12 (2.87)	26 (6.22)	36 (8.61)	123 (29.43)	117 (27.99)	88 (21.05)
Average 7.21; S.D.1.65									

Remark: Percentages in parentheses

5.8.7 Estimation of the Willingness–to–Pay (WTP) for management of natural resources to decrease the loss of human health, social assets, biodiversity, and primary production

After being given the attitude toward four areas of safeguard loss, the interviewer then presented Contingent Valuation (CV) hypothetical scenarios for

respondents to decide WTP. The result of the WTP of the sample group is shown in Table 5.9. From the analysis it was found that 400 samples supported a fund for management of natural resources and 18 samples did not support a fund for management of natural resources, reasons for which are shown in Table 5.10.

To decrease the loss of human health, in a comparison of the bid amount that respondents who are WTP to support the fund will pay, group 1 had 22 samples who were WTP the lowest bid amount while 11 samples were WTP the highest amount. Group 2 had 24 samples who were WTP the lowest bid amount while 14 samples were WTP the highest bid. Group 3 had 23 samples who were WTP the lowest bid amount while 9 samples were WTP the highest bid. Finally, group 4 had 23 samples who were WTP the lowest bid amount while 13 samples were WTP the highest bid.

To decrease the loss of social assets, in a comparison of the bid amount that respondents who are WTP to support the fund will pay, group1 had 20 samples who were WTP the lowest bid amount while 7 samples were WTP the highest bid. Group 2 had 22 samples who were WTP the lowest bid amount while 12 samples were WTP the highest bid. Group 3 had 21 samples who were WTP the lowest bid amount while 9 samples were WTP the highest bid. Finally, group 4 had 21 samples who were WTP the lowest bid amount while 12 samples were WTP the highest bid.

To decrease the loss of biodiversity, in a comparison of the bid amount that respondents who were WTP to support the fund will pay, group 1 had 20 samples who were WTP the lowest bid amount while 7 samples were WTP the highest bid. Group 2 had 22 samples who were WTP the lowest bid amount while 12 samples were WTP the highest bid. Group 3 had 21 samples who were WTP the lowest bid amount while 9 samples were WTP the highest bid. Finally, group 4 had 20 samples who were WTP the lowest bid amount while 11 samples were WTP the highest bid.

To decrease the loss of primary production, in a comparison of the bid amount that respondents who were WTP will pay, group 1 had 20 samples who were WTP the lowest bid amount while 7 samples were WTP the highest bid. Group 2 had 21 samples who were WTP the lowest bid amount while 12 samples were WTP the highest

bid. Group 3 had 21 samples who were WTP the lowest bid amount while 8 samples were WTP the highest bid. Finally, group 4 had 21 samples who were WTP the lowest bid amount while 12 samples were WTP the highest bid.

Table 5.9: WTP of bid price

(a) Human health

Bid price	Group 1		Group 2		Group 3		Group 4		Unsupported
	Yes	No	Yes	No	Yes	No	Yes	No	
100	22	3	24	1	23	2	23	2	5
200	18	7	19	6	20	5	18	7	4
500	15	10	15	10	18	7	18	7	5
1000	11	14	14	11	9	16	13	12	4
Total	66 (15.79)	34 (8.13)	72 (17.22)	28 (6.70)	70 (16.75)	30 (7.18)	72 (17.22)	28 (6.70)	18 (4.31)

Remark: Percentages in parentheses

(b) Social assets

Bid price	Group 1		Group 2		Group 3		Group 4		Unsupported
	Yes	No	Yes	No	Yes	No	Yes	No	
100	20	5	22	3	21	4	21	4	5
200	19	6	19	6	19	6	20	5	4
500	17	8	17	8	19	6	22	3	5
1000	7	18	12	13	9	16	12	13	4
Total	63 (15.07)	37 (8.85)	70 (16.75)	30 (7.18)	68 (16.27)	32 (7.66)	75 (17.94)	25 (5.98)	18 (4.31)

Remark: Percentages in parentheses

Table 5.9: WTP of bid price (cont.)

(c) Biodiversity

Bid price	Group 1		Group 2		Group 3		Group 4		Unsupported
	Yes	No	Yes	No	Yes	No	Yes	No	
100	20	5	22	3	21	4	20	5	5
200	20	5	19	6	19	6	17	8	4
500	16	9	17	8	19	6	22	3	5
1000	7	18	12	13	8	17	11	14	4
Total	63 (15.07)	37 (8.85)	70 (16.75)	30 (7.18)	67 (16.03)	33 (7.89)	70 (16.75)	30 (7.18)	18 (4.31)

Remark: Percentages in parentheses

(d) Primary production

Bid price	Group 1		Group 2		Group 3		Group 4		Unsupported
	Yes	No	Yes	No	Yes	No	Yes	No	
100	20	5	21	4	21	4	21	4	5
200	18	7	19	6	19	6	19	6	4
500	16	9	18	7	20	5	21	4	5
1000	7	18	12	13	8	17	12	13	4
Total	61 (14.59)	39 (9.33)	70 (16.75)	30 (7.18)	68 (16.27)	32 (7.66)	73 (17.46)	27 (6.46)	18 (4.31)

Remark: Percentages in parentheses

5.8.8 Reasons for unwillingness–to–pay (un–WTP) for management of natural resources to decrease the loss of human health, social assets, biodiversity, and primary production

Looking at reasons for un–WTP for management of natural resources to decrease the loss of human health from the sample group in Table 5.10(a), it was found that 2 reasons each had 3 samples, which is 2.22%, who were un–WTP: it would not be worth the investment, and they did not believe that the organization would do it; 33 samples, which is 24.44%, were un–WTP because they do not earn enough income; 49

samples, which is 36.30%, were un–WTP because they thought the government should pay for it out of tax money; two reasons each had 5 samples, which is 3.70%, who were un–WTP: cannot help the environment and no knowledge of environmental management; 11 samples, which is 8.15%, were un–WTP because there was not enough time for decision–making; 7 samples, which is 5.19%, were un–WTP because there was not enough information for decision–making; 6 samples, which is 4.44%, were un–WTP because there could be corruption in the project; 10 samples, which is 7.41%, were un–WTP because the government should use the funds for other projects; 1 sample, which is 0.74%, was un–WTP because no solution to the problems; 2 samples, which is 1.48% were un–WTP because there are no benefits to the project.

Looking at reasons for un–WTP for management of natural resources to decrease the loss of social assets from the sample group in Table 5.10(b), it was found that two reasons each had 4 samples, which is 2.90%, who were un–WTP: it would not be worth the investment, and not enough information for decision–making; 45 samples, which is 32.61%, were un–WTP because they do not earn enough income; 28 samples, which is 36.30%, were un–WTP because they thought the government should pay for it out of tax money; 9 samples, which is 6.52%, were un–WTP because they did not believe that the organization would do it; 13 samples, which is 9.42%, were un–WTP because the project cannot help the environment; 5 samples, which is 3.62%, were un–WTP because they had no knowledge of environmental management; 12 samples, which is 8.70%, were un–WTP because there was not enough time for decision–making; 8 samples, which is 5.80%, were un–WTP because there could be corruption in the project; 7 samples, which is 5.07% were un–WTP because the government should use the funds for other projects; 3 samples, which is 2.17%, were un–WTP because no solution to the problems.

Looking at reasons for un–WTP for management of natural resources to decrease the loss of biodiversity from the sample group in Table 5.10(c), it was found that there were 4 samples, which is 2.74%, who were un–WTP because it would not be worth the investment; 44 samples, which is 30.14%, were un–WTP because they do not earn enough income; 27 samples, which is 18.49%, were un–WTP because they thought

the government should pay for it out of tax money; 10 samples, which is 6.85%, were un–WTP because they did not believe that the organization would do it; there were 2 reasons which had 12 samples, which is 8.22%, who were un–WTP: the project cannot help the environment and not enough time for decision–making; there were 2 reasons which had 8 samples, which is 5.48%, who were un–WTP: no knowledge of environmental management and not enough information for decision–making; three reasons had 6 samples, which is 4.11%, who were un–WTP: corruption, funds should be used for other projects, and no solution to the problems; 3 samples, which is 2.05%, were un–WTP because the project has no benefits.

Looking at reasons for un–WTP for management of natural resources to decrease the loss of primary production from the sample group in Table 5.10(d), it was found that 2 reasons had 5 samples, which is 3.74%, who were un–WTP: not worth the investment, and not enough information for decision-making; 43 samples, which is 29.86%, were un–WTP because they did not earn enough income; 25 samples, which is 17.36%, were un–WTP because they thought the government should pay for it out of tax money; 2 reasons had 6 samples, which is 4.17%, who were un–WTP: cannot help the environment, and the government should use the funds for other projects; 11 samples, which is 7.64%, were un–WTP because the project cannot help the environment; 8 samples, which is 5.56%, were un–WTP because they had no knowledge of environmental management; 18 samples, which is 12.50%, were un–WTP because there was not enough time for decision–making; 9 samples, which is 6.25%, were un–WTP because there could be corruption in the project; 7 samples, which is 4.86%, were un–WTP because no solution to the problems; 1 sample, which is 0.69%, was un–WTP because there are no benefits of the project.

Table 5.10: Reason for non–WTP

(a) Human health

Main reason	Group1	Group2	Group3	Group4	Total	
					Number	%
1) This project is not worth the investment	0	2	0	1	3	2.22
2) Not enough income	12	10	7	4	33	24.44
3) The government should pay for it out of tax money	13	8	14	14	49	36.30
4) Not believe that the organization would do it	0	0	3	0	3	2.22
5) This project cannot help the environment	3	0	0	2	5	3.70
6) No knowledge of environmental management	0	2	2	1	5	3.70
7) Not enough time for decision–making	2	2	3	4	11	8.15
8) Not enough information for decision–making	1	1	1	4	7	5.19
9) Corruption	2	3	0	1	6	4.44
10) Government should use the funds for other projects	4	3	3	0	10	7.41
11) No solution to the problems	0	1	0	0	1	0.74
12) No benefits of this project	1	0	0	1	2	1.48
Total	38	32	33	32	135	100

(b) Social assets

Main reason	Group1	Group2	Group3	Group4	Total	
					Number	%
1) This project is not worth the investment	1	2	0	1	4	2.90
2) Not enough income	13	10	17	5	45	32.61
3) The government should pay for it out of tax money	10	7	8	3	28	20.29
4) Not believe that the organization would do it	3	0	3	3	9	6.52
5) This project cannot help the environment	6	1	0	6	13	9.42
6) No knowledge of environmental management	2	1	1	1	5	3.62
7) Not enough time for decision–making	2	3	4	3	12	8.70
8) Not enough information for decision–making	1	1	0	2	4	2.90
9) Corruption	1	4	1	2	8	5.80
10) Government should use the funds for other projects	3	1	2	1	7	5.07

Table 5.10: Reason for non–WTP (Cont.)

Main reason	Group1	Group2	Group3	Group4	Total	
					Number	%
11) No solution to the problems	0	2	0	1	3	2.17
12) No benefits of this project	0	0	0	0	0	0
Total	42	32	36	28	138	100

(c) Biodiversity

Main reason	Group1	Group2	Group3	Group4	Total	
					Number	%
1) This project is not worth the investment	3	0	0	1	4	2.74
2) Not enough income	13	11	15	5	44	30.14
3) The government should pay for it out of tax money	9	6	9	3	27	18.49
4) Not believe that the organization would do it	3	1	2	4	10	6.85
5) This project cannot help the environment	2	2	4	4	12	8.22
6) No knowledge of environmental management	4	0	1	3	8	5.48
7) Not enough time for decision–making	2	3	2	5	12	8.22
8) Not enough information for decision–making	0	1	2	5	8	5.48
9) Corruption	1	4	0	1	6	4.11
10) Government should use the funds for other projects	3	1	1	1	6	4.11
11) No solution to the problems	1	4	1	0	6	4.11
12) No benefits of this project	1	0	1	1	3	2.05
Total	42	33	38	33	146	100

(d) Primary production

Main reason	Group1	Group2	Group3	Group4	Total	
					Number	%
1) This project is not worth the investment	2	1	1	1	5	3.47
2) Not enough income	12	10	16	5	43	29.86
3) The government should pay for it out of tax money	9	6	7	3	25	17.36
4) Not believe that the organization would do it	2	2	0	2	6	4.17
5) This project cannot help the environment	5	2	2	2	11	7.64
6) No knowledge of environmental management	2	0	1	5	8	5.56

Table 5.10: Reason for non–WTP (Cont.)

Main reason	Group1	Group2	Group3	Group4	Total	
					Number	%
7) Not enough time for decision–making	4	2	6	6	18	12.50
8) Not enough information for decision–making	0	1	1	3	5	3.47
9) Corruption	3	4	1	1	9	6.25
10) Government should use the funds for other projects	4	1	0	1	6	4.17
11) No solution to the problems	1	4	1	1	7	4.86
12) No benefits of this project	0	0	1	0	1	0.69
Total	44	33	37	30	144	100

5.8.9 Willingness–to–pay for management of natural resources to decrease the loss of human health, social assets, biodiversity, and primary production

Table 5.11 shows the results of the calculation of respondents' in the above manner based on probit regression analysis. The WTP estimated for human health is the highest, while that for biodiversity has the lowest value. However, those WTP values were the same results.

Table 5.12 shows multivariate regression analysis which found that the only three explanatory variables which were found to significantly influence WTP for management of natural resources are gender, the environmental concern in Thailand, and attitudes toward environmental damage. This is consistent with the a priori expectation that the price of the good and ability to pay would influence peoples' willingness to purchase the good. The coefficient negatively influenced WTP indicating that the higher the variables, the less likely respondents would be willing to pay to support the management of natural resources. On the other hand, group of respondents, gender, and income affect WTP in the positive direction. The higher they are, the more people want to pay.

Table 5.11: The calculated result of contingent valuation analysis

WTP	Mean $WTP_{1,e}$ (Baht/unit[1])	Standard error	Z	Pseudo R^2	Log likelihood	95% confidence	
						Lower	Upper
Human health	856.80	89.04	9.62	0.1168	-234.15	682.28	1031.34
Social assets	835.51	89.92	9.29	0.0878	-244.34	659.28	1011.74
Biodiversity	787.94	81.25	9.70	0.0896	-247.34	628.70	884.83
Primary production	809.06	86.10	9.40	0.0872	-246.88	640.31	947.19

Remark: [1]Human health is unit DALY/person;
Social asset is unit Baht/person;
Biodiversity is unit EINES/person;
Primary production is unit kg/person

Table 5.12: Multivariate probit analysis

(a) Human health

Covariates	Coefficients	Standard error	t value	p value
Bid	-0.0003897	0.0000664	-5.87	***
Group	0.0215424	0.0197166	1.09	**
Gender	0.0012538	0.0448268	0.03	*
Age	-0.0320689	0.0211716	-1.51	**
Income	0.0694568	0.0182728	3.80	***
Marital status	-0.0474337	0.0499909	-0.95	**
Education	-0.1774731	0.0488341	-3.63	***
Environmental damage on area of safeguard attribute	-0.0056859	0.0213638	-0.27	**
Knowledge	-0.1500055	0.0796243	-1.88	**
Environmental concern	-0.000439	0.0067664	-0.06	*
General problem concern	0.0177773	0.0079762	2.23	**
Loss of safeguard subject attribute	-0.0350329	0.0232161	-1.51	**
Loss of damage attribute	-0.004772	0.0146164	-0.33	*
Constant	1.053158	0.2650133	3.97	

Remark: * $p < 1$; **$p < 0.5$; ***$p < 0.0001$;

Table 5.12: Multivariate probit analysis (cont.)

(b) Social assets

Covariates	Coefficients	Standard error	t value	p value
Bid	-0.0003937	0.0000679	-5.80	***
Group	0.034165	0.0201962	1.69	**
Gender	0.0806451	0.0460209	1.75	*
Age	0.0279692	0.0217658	1.29	**
Income	0.0423579	0.0187098	2.26	***
Marital status	-0.0042681	0.0512649	-0.08	**
Education	0.0470849	0.0500215	0.94	***
Environmental damage on area of safeguard attitude	-0.0217043	0.0219272	-0.99	**
Knowledge	0.1336343	0.081573	1.64	**
Environmental concern	0.0071275	0.0068579	1.04	*
General problem concern	0.0094046	0.0082008	1.15	**
Loss of safeguard subject attitude	-0.0305751	0.0292353	-1.05	**
Loss of damage attitude	0.011929	0.0143731	0.83	*
Constant	0.082851	0.2539517	0.33	

Remark: * $p < 1$; **$p < 0.5$; ***$p < 0.0001$;

(c) Biodiversity

Covariates	Coefficients	Standard error	t value	p value
Bid	-0.0004082	0.0000685	-5.96	***
Group	0.0136969	0.0203526	0.67	**
Gender	0.061863	0.0462895	1.34	*
Age	0.0379721	0.0218155	1.74	**
Income	0.0379701	0.0188366	2.02	***
Marital status	-0.0070244	0.0516135	-0.14	**
Education	0.0502146	0.0507009	0.99	***
Environmental damage on area of safeguard attitude	-0.0238683	0.0220159	-1.08	**
Knowledge	0.1339453	0.082589	1.62	**
Environmental concern	0.0057881	0.0068956	0.84	*
General problem concern	0.0107165	0.0082422	1.30	**
Loss of safeguard subject attitude	0.0017822	0.0279196	0.06	**
Loss of damage attitude	0.0366694	0.0148565	2.47	*
Constant	-0.127327	0.2668906	-0.48	

Remark: * $p < 1$; **$p < 0.5$; ***$p < 0.0001$;

Table 5.12: Multivariate probit analysis (cont.)

(d) Primary production

Covariates	Coefficients	Standard error	t value	p value
Bid	-0.0003986	0.0000684	-5.83	***
Group	0.0337295	0.0203398	1.66	**
Gender	0.0653886	0.0464059	1.41	*
Age	0.0345007	0.0218419	1.58	**
Income	0.0327449	0.0188428	1.74	***
Marital status	0.0076458	0.0515483	0.15	**
Education	0.0293679	0.05037	0.58	***
Environmental damage on area of safeguard attitude	-0.0204253	0.0219663	-0.93	**
Knowledge	0.0880633	0.0821521	1.07	**
Environmental concern	0.0063307	0.0068931	0.92	*
General problem concern	0.0083118	0.0082356	1.01	**
Loss of safeguard subject attitude	-0.0623778	0.0282337	-2.21	**
Loss of damage attitude	0.0178312	0.0137869	1.29	*
Constant	0.1869122	0.258809	0.72	

Remark: * $p < 1$; **$p < 0.5$; ***$p < 0.0001$;

5.9 Weighting factor for impact assessment model

Results from Table 5.11 were coefficients of four areas of safeguard: human health, social assets, biodiversity, and primary production with 856.80, 835.51, 787.94, and 809.06 in units of Baht/DALY, Baht/Baht, Baht/EINES, and Baht/kg, respectively. By using the application of weighting factors, they can be calculated as a monetary value per unit of safeguard subject with equation (5.1) (Itsubo *et al.* 2004):

$$I_1 = \sum_e \sum_s \left(Inv._s \times \mathrm{DF}_{s,e} \times \mathrm{WF}_{1,e} \right) \quad (5.1)$$

where I_1 is a result of weighting in LCIA based on the economic valuation (Baht);

$Inv._s$ is a result of LCI of substance *s* (kg);

$DF_{s,e}$ is an amount of Damage Factor (DF) of substance *s* on an endpoint *e*;

$WF_{1,e}$ is a monetary value for one unit of damage to a safeguard subject (Baht/unit damage amount).

Table 5.13 is shown an example of coefficients of global warming and other impacts in Appendix F.

Table 5.13: An example of characterization, damage, and weighting coefficients of global warming

No.	Common name	Chemical formula	Global warming characterization factor (kg CO_2 eq.)	Damage			Weighting (Baht/kg)		
				Human health (DALY/kg)	Social assets (Baht/kg)	Primary production (kg/kg)	Human health	Social assets	Primary production
1	Carbon dioxide	CO_2	1	5.50E-07	6.39E-12	4.98E-05	4.71E-04	5.34E-09	4.03E-02
2	HFC-134a	$C_2H_3F_3$	1430	8.60E-04	9.99E-09	7.79E-02	7.37E-01	8.35E-06	6.30E+01
3	Halon 1301	$CBrF_3$	7140	-3.66E-02	-4.25E-07	-3.31E+00	-3.14E+01	-3.55E-04	-2.68E+03
4	HCFC-22	$CHClF_2$	1810	8.80E-04	1.02E-08	7.97E-02	7.54E-01	8.54E-06	6.45E+01
5	CFC-13	$CClF_3$	14420	8.68E-03	1.01E-07	7.86E-01	7.44E+00	8.42E-05	6.36E+02
6	CFC-12	CCl_2F_2	10890	1.39E-03	1.61E-08	1.25E-01	1.19E+00	1.34E-05	1.01E+02
7	CFC-11	CCl_3F	4750	-6.86E-04	-7.97E-09	-6.21E-02	-5.88E-01	-6.66E-06	-5.03E+01
8	Sulfur hexafluoride	SF_6	22810	1.27E-01	1.48E-06	1.15E+01	1.09E+02	1.24E-03	9.33E+03

5.10 Discussion

This study found that environmental damage in Thailand had a positive WTP for environmental protection to decrease loss of human health, social assets, biodiversity and primary production. Although, the respondents were willing to pay for environmental protection, mot did not seem to know about the major problems. Thai people think that it's very important to make a fund for environmental protection. Thus, the study could not directly say that the respondents are WTP for the protection of the environment to reduce the loss of human health, social assets, biodiversity, and primary production.

Weighting across the four safeguard areas defined in the LCIA method can be calculated by multiplying the Weighting Factor ($WF_{1,e}$), obtained from Table 5.11 by the normalization values (Based on the LIME method) in Table 5.14. The results are shown in Table 5.15. However, it should be noted that the annual damage data is based on Japanese data, therefore the damage cannot be compared, only tendency for fraction damage.

The LIME method (Itsubo *et al.*, 2004; Murakami *et al.*, 2012), conducted a relative comparison of LCIA damage in four areas – human health, social assets, biodiversity, and primary production, by conjoint analysis. The weighting factors for human health, social assets, biodiversity, and primary production were 0.31: 0.21: 0.26: 0.23. Eco–indicator99 (Goedkoop and Spriensma, 1999) conducted a relative comparison of LCIA damage in three areas – human health, ecosystem quality, and resources, by panel method. It employed cultural theory, and classified the items into three patterns – hierarchist, egalitarian, and individualist perspectives – and evaluated their weighting factors. The weighting factors for human health, ecosystem quality, and resources were 4:4:2 for the hierarchist perspective, 3:5:2 for the egalitarian perspective, and 5.5:2.5:2 for the individualist perspective, respectively. Because the evaluation of the ecosystem quality in Eco–indicator 99 is the aspect that uses ratios of disappeared species as an index, the biodiversity is the closest match among the targets of the current research.

Table 5.14: Normalization values for safeguard areas in Thailand based on the LIME method

Safeguard subject	Human health	Social assets	Biodiversity	Primary production
Unit	*DALY*	*Baht*	*EINES*	*Dry–ton*
Global warming	2.41E+04	1.24E+05		
Ozone layer depletion	1.44E+03	3.26E+00		1.15E+05
Acidification		2.97E+04		4.64E+05
Eutrophication		2.24E+03		
Photochemical oxidation creation	3.96E+03	5.13E+03		
Urban air pollution	9.72E+04			
Toxic chemical	1.11E+04			
Ecotoxicity			1.27E-02	
Land use			5.07E-02	1.78E+07
Resource depletion		7.01E+04	1.69E-01	3.04E+07
Waste			1.85E-03	4.31E+05
Normalization value	**1.38E+05**	**2.31E+05**	**2.34E-01**	**4.92E+07**

Source: Itsubo *et al.,* (2004)

Remark: Conversion value is 0.25 based on GDP(PPP) in Thailand at 8,703 Baht, and Japan at 34,299 Baht and based on 2012.

Table 5.15: The relative weighting factors based on annual damage from Japan

WTP	Annual damage	Weighting factor$_{2,e}$
Human health	7.56E+15	0.34
Social assets	1.24E+16	0.55
Biodiversity	1.18E+10	5.26E-07
Primary production	2.55E+15	0.11

Remark: [1]Based on population of 64,076,033 peoples (National Statistical Office Thailand, 2011)