EVALUATING THE ECOSYSTEM SERVICES-RELATED QUALITY OF LIFE (E-QOL) OF STUDENTS IN THE URBAN AREAS

Emma ABASOLO[1], Takanori MATSUI[2], Osamu SAITO[3], and Tohru MORIOKA[4]

[1]Member of JSCE, Graduate School of Engineering, University of Osaka
(Yamadaoka 2-1, Suita-shi, Osaka 565-0841, Japan)
E-mail: emma@em.see.eng.osaka-u.ac.jp
[2]Member of JSCE, Dept of Engineering, University of Osaka
(Yamadaoka 2-1, Suita-shi, Osaka 565-0841, Japan)
[3]Member of JSCE, Dept of Engineering, University of Osaka
(Yamadaoka 2-1, Suita-shi, Osaka 565-0841, Japan)
[4]Member of JSCE, Professor, Dept of Engineering, University of Osaka
(Yamadaoka 2-1, Suita-shi, Osaka 565-0841, Japan)

Rapid and continuous urbanization is inevitable in the very near future. This phenomenon is the cause of many problems that could adversely affect the quality of life (QOL) of urban area inhabitants. Urban green spaces could address these problems by providing various benefits, which are known as ecosystem services (ES). This research focuses on the ES-related QOL or E-QOL, which is defined as "the satisfaction with ES weighed by the scale of importance". The Kanto region was chosen as the study site due to its importance to Japan economically and socially. Survey was conducted among students from three universities within Kanto region. Action Grid Analysis shows that the priority ES in the urban area are: air pollution control, greenhouse gas reduction, heat island mitigation, and water pollution control. The sources of these four ES as well as their quantity and quality should be improved to increase E-QOL. Simultaneous multiple regression result shows that importance of water pollution control and satisfaction with air pollution control could be used to predict the E-QOL. Other factors such as urbanization promotion area and land-use changes were used to differentiate the importance and satisfaction with each of the ES.

Key Words: *Ecosystem Services, Quality of Life, Urban Area, Action Grid Analysis*

1. INTRODUCTION

Rapid and continuous urbanization is inevitable in the very near future. When this happens, there will be a plethora of issues facing the cities of today including but not limited to air and water pollution, heat island effect, global warming, occurrence of disasters like floods and earthquakes, noise and light pollution, and food and freshwater shortage. Consequently, these would have salient influences on the urban residents' quality of life or QOL[1).

Studies revealed that urban green spaces provide various environmental, economic, and social benefits that can contribute to the QOL in cities. These benefits are known as ecosystem services (ES). It is, therefore, critical that urban planning should primarily aim to sustain and enhance the QOL of cities and regions - to improve the quality of the environment as well as the quality of life of individuals and communities in the city.

The term "QOL" can be defined as a combination of life conditions and satisfaction with these conditions weighted by scale of importance, which is decided by the individual[2). This paper focuses only the ES-related Quality of Life or "E-QOL" so the aforementioned definition was modified as "the satisfaction with ES weighed by the scale of importance". The main goal of this paper is to improve the E-QOL of the urban residents, that is, the E-QOL of the individuals in the city.

The Action Grid Analysis (AGA)[3) is a unique tool that allows public officials to better understand the highly important decision making criteria for each of the services they are providing. This is based on the concept that cities

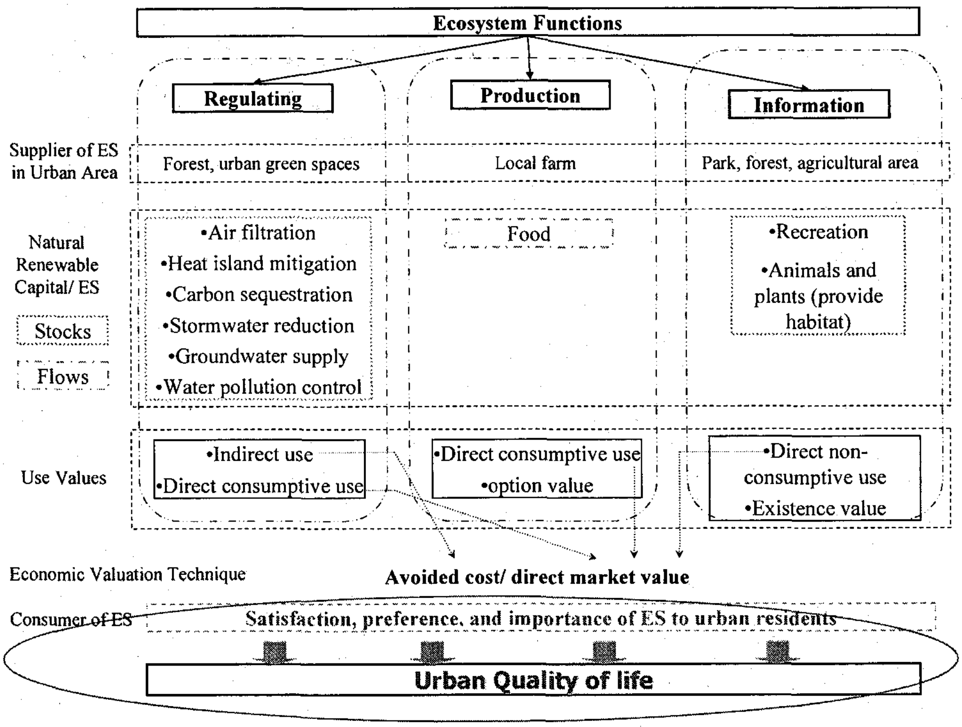

Fig.1 Research framework for measuring ES' contribution to urban QOL

will maximize overall citizen satisfaction by emphasizing improvements in those service categories where the level of satisfaction is relatively low and the perceived importance of the service is relatively high.

The overall satisfaction of the students with ES was determined using the single item rating of general satisfaction. The general satisfaction is a very important topic that is widely used especially in QOL studies and consumer behavior analysis. In this research, the satisfaction and importance of each ES is used to predict general satisfaction. Hence, general satisfaction will be used interchangeably with E-QOL.

This paper was designed based on the framework presented in our former paper[4] (**Fig. 1**). This framework is based on De Groot et al. (2002)[5] wherein he proposed an integrated assessment and valuation of ES in three types: ecological, socio-cultural and economic values; and Daily et al. (2003)[6] believed that in valuation, the integration of economic and ecological understanding is crucial. We recognize the limitation of this study because it focuses only on the role of the environment to QOL, which is only one aspect or domain in QOL analysis. Nevertheless, this research is a pioneer in that it is one of the firsts to assess the contribution of the environment in terms of ES to QOL using importance and satisfaction scores.

The questions that paper will address are the following:

1) To assess the relationship between importance and satisfaction of each of the ES: air pollution control, heat island mitigation, green house gas reduction, storm and flood protection, water supply, water pollution control, recreation, food, and habitat provision.
2) To predict the general satisfaction by modeling using the importance and satisfaction to each of the ES

Knowledge concerning the importance and satisfaction of the urban respondents with ES, as well as the general satisfaction is a very important aspect in measuring the E-QOL. This research aims to assess which should be the priority ES for urban planning and suggest how to improve or increase E-QOL in the urban area using AGA as a tool, which can be used to identify and prioritize the types of ES for urban planning.

2. MATERIALS AND METHODS

(1) Questionnaire design

As identified in Abasolo et al. (2006)[4], the following ES are pointed out as extremely important in the urban area: air pollution control, natural cooling system (heat island mitigation), greenhouse gas reduction, storm and flood protection, water supply, water pollution control, recreation, food production, and habitat provision. Consequently, these ES were used in making the questionnaire.

The survey questionnaire was composed of three parts: 1) knowledge and recognition of ES (importance), 2) satisfaction with ES, and 3) socio-demographic background. The first part seeks to know the importance of each ES. The second part aims to measure the respondents' satisfaction with each ES. The third part was used to analyze the relationship between the first two parts and the socio-demographic background. Refer to **Table 1** to see the sample questions used in the survey questionnaire.

(2) Locale of the study

The Kanto region was chosen as the study area. This region encompasses seven prefectures: Gunma, Tochigi, Ibaraki, Saitama, Tokyo, Chiba, and Kanagawa. It is the most highly developed, urbanized, and industrialized part of Japan. Tokyo and Yokohama alone form a single industrial complex of light and heavy industries along the Tokyo Bay. It is also very highly populated, in fact, the densely inhabited districts (DID) 2000 population of Tokyo is 8.1 million and Yokohama is 3.3 million)[7], which is ranked first and second, respectively in the whole country. With the urbanization of Greater Tokyo, environmental problems arose, such as deterioration of the river water quality, change in the ecosystem and variation in the landscape. Albeit the importance of this area not only to the economy of Japan, but also in it being the home to many urban residents, it is crucial to improve the quality of the environment in the Kanto region. For these reasons, it was chosen as the study site.

Table 1 Sample questions used in this study

Survey Questions:

1) Regarding the 9 ecosystem services, which do you think is the <u>most important?</u> Please rank each one according to importance: from most important to least important

1. air pollution control
2. heat island mitigation
3. green house gas reduction
4. storm and flood protection
5. water supply
6. water pollution control
7. recreation
8. food
9. habitat provision

Ex) Most important [2]→[4]→[6]→[1]→[8]→[7]→[3]→[5]→[9] Least important

Most important □→□→□→□→□→□→□→□→□ Least important

2) Are you <u>satisfied with the present level</u> of the 9 ecosystem services in your area? Rate each of the ES according to your level of satisfaction.

	Very satisfied	Satisfied	Neither satisfied nor not satisfied	Not satisfied	Not satisfied at all	Undecided
1. air pollution control						
2. heat island mitigation						
3. green house gas reduction						
4. storm and flood protection						
5. water supply						

3) Socio-demographic Characteristics

How old are you? □ *15～24 yrs old* □ *25～44 yrs old* □ *45～64 yrs old* □ *65 yrs old and above*

What is your gender? □ *Male* □ *Female*

What is your present job or work? □ *Private company or industry* □ *Government Employee* □ *Own business* □ *Student* □ *Part-time job* □ *No occupation* □ *Others* (__________)

Where do you live? Please write in the space provided:

________ Province ________ City ________

(3) The sampling design

Questionnaire data were collected from the undergraduate students of three universities within the Kanto area - Takasaki City University of Economics (Gunma) Department of Engineering, Toyo University (Saitama), and School of Media and Governance (Kanagawa), Keio University. The three universities were chosen primarily based on the geography or location within Kanto region. Gunma is on the northwest corner, which is mostly mountainous; Saitama is on the middle part, which is often described as suburbs of Tokyo; and Kanagawa is on the southern part, wherein its eastern side is heavily urbanized.

(4) The sample

The samples in this study were all the students who attended the randomly chosen classes in the three universities on the day the survey was conducted. The total number of answered questionnaires received was 35 on November 2, 99 on December 1, and 33 on December 6, 2006. The total number of samples was 167, but only 164 samples were used because the three questionnaires were invalid (i.e., not fully answered by the respondent). Since the samples we collected for this study are limited to university students, this paper should be considered as a preliminary study on E-QOL. Chapters 3 and 4 were revised considering this limitation.

3. RESULTS AND DISCUSSION

(1) Socio-demographic characteristics of the respondents

Data gathered from the interview were processed using the SPSS statistical software. Descriptive statistics such as frequency distributions, percentages, and means were computed to generate a distribution of responses. Most of the respondents are under 24 years old (94%). There are more male (68%) than female (32%) respondents.

Fig. 2 shows the respondent distribution by prefecture. In this study, the respondents' residences were categorized based on the classification by the Ministry of Agriculture, Forestry and Fisheries[8] wherein urban areas are those with population density of more than 500 persons per km^2, and densely-inhabited area (DID) population is more than 20,000 persons. All of the respondents' residence area fell under the urban area of this classification standard.

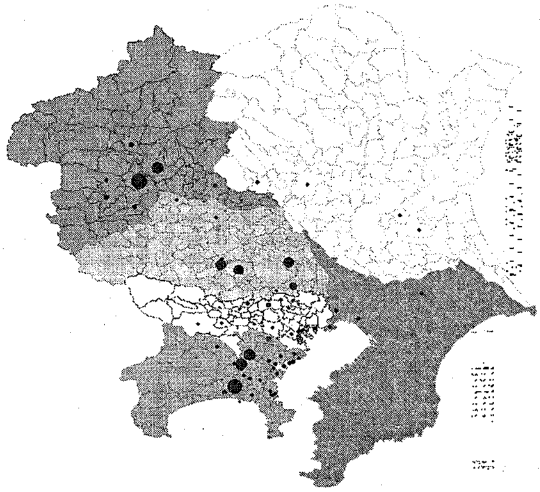

Fig. 2 Respondent distribution

There are 1 respondent(s) from the prefecture of Ibaraki, 2 from Tochigi, 87 from Gunma, 25 from Saitama, 4 from Chiba, 13 from Tokyo, and 24 from Kanagawa.

(2) Importance and satisfaction with ecosystem services

a) Importance

The respondents are highly knowledgeable with the nine ecosystem services. The means ranged from 1.40 to 1.87 on a scale of zero (not aware) to two (aware). The importance of each ES was originally rated from highest to lowest (with 9 being the highest and 1 being the lowest). But this was converted to an equivalent Likert scale of 1 – 5 so that the importance scale will be the same as that of the satisfaction scale which is important when plotting in the action grid analysis graph which will be shown later. The scale of 1-2 pertains to *negative importance*, 3 to *indifferent*, and 4-5 to *positive importance*. One can see that important ES (positive importance) which were in bold font in **Table 2** were air pollution control, heat island mitigation, green house gas reduction, water supply, and water pollution control while the not important (negative importance) ES were storm and flood protection, food provision, habitat provision, and recreation. The study of Chen (2005)[9] in China shows that the most important ES were the benefits related to weather amelioration like oxygen release, carbon dioxide sequestration, air pollutant adsorption, shading, as well as noise abatement and places for recreational activities. This is in agreement with the result of our study except that of recreation. Moreover,

Table 2 Percent importance and satisfaction distribution scores

Ecosystem Services	% Importance Level			% Satisfaction Level		
	Negative importance	Indifferent	Positive importance	Negative satisfaction	Indifferent	Positive satisfaction
Air pollution control	14.47	13.82	**71.71**	**47.44**	21.15	26.28
Heat island mitigation	41.45	9.21	**49.34**	**50.64**	24.36	17.95
Green house gases reduction	32.89	8.55	**58.55**	**51.92**	26.28	10.90
Storm and floods protection	**53.29**	11.18	35.53	30.13	24.36	**35.90**
Water supply	23.68	14.47	**61.84**	24.36	26.92	**33.97**
Water pollution control	34.21	19.08	**46.71**	**36.54**	30.13	23.72
Recreation	**89.47**	3.29	7.24	23.72	32.69	**39.10**
Food provision	**52.63**	11.18	36.18	27.56	27.56	**33.97**
Habitat provision	**60.53**	9.87	29.61	**39.10**	29.49	23.08

in the study of Lohr et al. (2004)[10] the least important reason for having trees was to attract wildlife, which is also somehow similar to the result of our study because among the ES that are scored as not important in **Table 2**, majority of the respondents scored habitat provision as second to the highest next to recreation. This means that it was identified as following the least important ES.

b) Satisfaction

The attitude of the respondents concerning the satisfaction with the nine ecosystem services was analyzed using a 5-point Likert scale with 1 being not satisfied a bit, 3 being indifferent and 5 being satisfied. With the three ES: air pollution control, heat island mitigation, and greenhouse gas reduction, most of the respondents are a little bit not satisfied. On the other hand, most of the respondents are neither satisfied nor not satisfied (indifferent) with water supply (26.92%), water pollution (30.13%), habitat provision (29.49%), and recreation (32.69%) i.e., % shows the highest percentage of responses of the majority. However, with storm and flood protection, recreation and food provision, most of the respondents are a little bit satisfied.

To further test the attitude of the respondents, the scale of 1-2 (i.e., not satisfied and not satisfied a bit scores) were combined to represent the *negative satisfaction*, the scale of 4-5 (i.e., satisfied and satisfied a bit scores) were also combined to represent the *positive satisfaction* with ES, and the scale of 3 was retained to pertain to *indifferent*. The result in **Table 2**, in which the answer of the majority is also highlighted in bold fonts, shows that in five out of the nine ES, most of the respondents have negative satisfaction, which means that they are not satisfied with air pollution control, heat island mitigation, greenhouse gas reduction, water pollution control, and habitat provision. One can note that there is an increase in the percentage of responses in water pollution control and habitat provision because these two ES are initially rated as belonging to neutral satisfaction, and now to the negative satisfaction.

(3) Action grid analysis: E-QOL analysis

The Action Grid Analysis (AGA) is actually a set of x and y-axes corresponding to "importance" and "satisfaction," respectively. The matrix consisted of four quadrants that are divided into priorities for management. Quadrant I includes ES that are rated high in both importance and satisfaction, and referred to as "well provided." Quadrant II includes ES that are rated high in importance but low in satisfaction, and are referred to as "high priority." Quadrant III includes ES that are rated low in both importance and satisfaction and are referred to as "low priority". Finally, Quadrant IV includes ES rated low in importance and high in satisfaction, referred to as "meeting/exceeding the need." All the ES that fall under the "high priority" quadrant are identified as the priority ES for policy recommendation[3].

Mean rating for the importance and satisfaction of each of the ES were calculated and were plotted using the AGA, also known as the Importance-Satisfaction (Performance) Matrix.

It is important to consider the relationship between importance and satisfaction because the degree and magnitude of the correlations could reduce the effectiveness of the AGA grids as a tool for policymaking.

Correlation analysis between importance and satisfaction shows that the Pearson correlations of the nine ES range from -0.04 to 0.07, meaning very weak and not significant correlations. As a result, the study presented here was free of this concern.

Fig. 3 shows the plot of the means of the importance and satisfaction of the nine ES. One can see from the figure that the ES that fell under the "high priority" quadrant in the Kanto area are: air pollution control, heat island mitigation, green house gas reduction, water supply, and water pollution control. Kanto area could most probably improve overall resident satisfaction or E-QOL by emphasizing improvements in these ES where the level of satisfaction is relatively low and the perceived importance of the service is relatively high.

Since the goal is to increase the satisfaction with these ES: air pollution control, heat island mitigation, green house gas reduction, water supply and water pollution, it is necessary to understand why the respondents were not satisfied with each of them so that the focus would be how to meet their needs and expectations. In the survey questionnaire, the respondents were asked for reasons why, if they are not satisfied with the ES. Some of the responses were related to the effects of ES and the number of trees, wherein the effects of ES are not evident and they cannot feel the changes caused by them, and there are very few trees in the urban area or these are not enough. In other words, the respondents cannot see or feel that the ES could indeed reduce air and water pollutants, lower the temperature, store carbon dioxide, and control groundwater recharge because there is limited or very little number of trees in the urban areas. Accordingly, there is a need to increase number of trees.

(4) Factors affecting importance and satisfaction

In analyzing the factors affecting importance and satisfaction, a one-way ANOVA was conducted to see if there is a variation among different urbanization promotion area sizes (comparing small, medium and large urbanization areas), gross area sizes (also comparing small, medium and large gross areas), and land-use changes (comparing decreasing, no change, and increasing land-use areas). These three factors were chosen as physical indicators that had a spatial representation, could act as independent factors or controllable attribute to test any significant difference in each of the ES, are well associated with policy-making, and are available for Kanto area. More than six other physical indicators like urbanization level by DID, green spaces used, arable land-use, and the like were tested but did not show any statistical differences at 5% significance level, so those were omitted in the analysis, and only the three factors were selected.

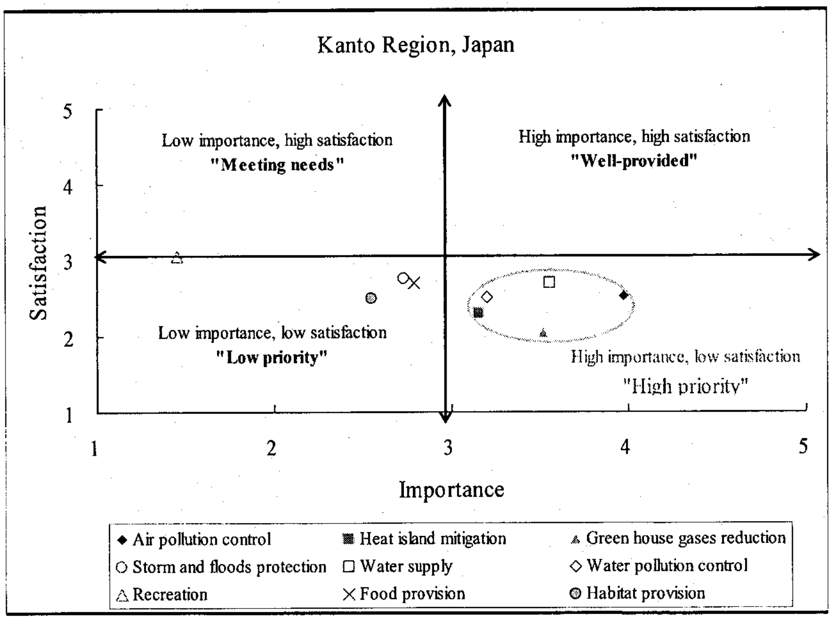

Fig. 3 E-QOL Analysis in Kanto Region, Japan

a) Urbanization promotion area

In Japan, land use zoning is one of most important methods of city planning for carrying out rational and effective land use development to ensure comfortable and functional urban environments. City planning areas are divided in principle into two areas of Urbanization Promotion Area and Urbanization Control Areas in order to prevent disorderly urbanization and achieve urbanization according to planning. Urbanization promotion areas are either areas that have already been urbanized or areas to be urbanized under planning in about ten year's time. Urbanization control areas are areas where urbanization must be kept in check.

In other countries, this concept is similar to urban growth boundary, which is defined as a regional boundary that attempts to control urbanization by drawing a line around the urban area outside of which development is prevented or highly discouraged[11]. Urban growth boundary is also referred to as urban growth area or urban service area. Places with urban growth boundaries include Oregon and Washington in United States, Vancouver and British Columbia in Canada, London in United Kingdom, and Melbourne in Australia.

Data for urbanization promotion area was obtained from Ministry of Agriculture (2006)[12]. In this paper, the data were subdivided as follows: small (0-4,211 ha), medium (4,212-12,695 ha) and large (12,696-58,157 ha) i.e., these definitions are not coming from the Ministry of Agriculture.

There is a statistically significant difference in the importance to storm and flood protection and food provision among small, medium and large urbanization promotion area as shown in **Table 3**. Post hoc Turkey HSD test indicates that the importance of storm and flood protection is significantly different between small and large area; and the importance of food provision is significantly different between small, medium and large areas (highlighted in bold in **Table 3**).

One can see that there is an inverse relationship between the importance of storm and flood protection and urbanization promotion area wherein the smaller the area, the greater is the importance of storm and flood protection. Small urbanization area tends to give the highest importance to storm and flood protection as compared to the medium and large areas. In the small urbanization area, the facilities for storm and flood protection such as dikes and dams may be limited in number, or are much smaller as compared to large urbanization area with highly developed dikes and dams. For this reason, ES for storm and flood protection is most likely much more needed in smaller urbanization area.

On the other hand, importance of food provision shows positive relationship with urbanization promotion area. The bigger the area allowed for urbanization, the higher the importance of food becomes. This could be explained by the fact that as the population escalates with the increase in urbanization area sizes, so is the demand for food to feed the increasing population (Refer to **Table 4**).

b) Gross planted area

It is very important to measure the quantity and quality of the sources of ES. In this research, the gross of planted area or areas with vegetation (like trees, crops, etc.) was used to approximate the quantity of ES. The data was obtained from the Ministry of Agriculture (2004)[13] and was divided into small (1,292-10,916 ha), medium (10,917-30,742 ha), and large (30,743-61,662 ha).

There is a statistically significant difference in the importance of storm and flood protection and food

Table 3 Selected ES having significant differences in the means of urban promotion area, gross planted area and land-use change

Importance of Ecosystem Services	**Urbanization promotion area mean** (df: 2, 150)			**Gross planted area mean** (df: 2, 150)			**Land-use changes mean**				
							Agricultural land-use change (df: 2, 150)			**Urban land-use change** (df: 1, 151)	
	Small	**Medium**	**Large**	**Small**	**Medium**	**Large**	**Decreasing**	**No change**	**Increasing**	**No change**	**Increasing**
Storm and floods protection	**4.77**	4.73	**2.82**	**4.88**	**4.42**	**2.83**					
	F=5.04**			F=5.89**							
Water supply							5.13	6.18	5.00	5.36	6.18
							F=3.35*			F=4.60*	
Food provision	**3.70**	**4.94**	**5.41**	**3.56**	**4.84**	**5.50**					
	F=5.30**			F=5.29**							

Note: **p<0.01, * p<0.05, df means degrees of freedom

Table 4 Various statistical data for small, medium, and large urbanization area

	Urbanization promotion area (2006)*		
	Small	Medium	Large
Population change (1970-1990)[14]	Increasing (30)	Increasing (7)	Increasing (3)
Agricultural land-use change ha (1970-90)[15]	Decreasing (-17)	Decreasing (-5)	Decreasing (-4)
Urban land-use change ha (1970-90)[15]	Increasing (30)	Increasing (14)	Increasing (8)
Primary industry change (1990-2000)[16]**	Decreasing (-39)	Decreasing (-86)	Decreasing (-16)
Secondary industry change (1990-2000)[16]**	Increasing (28)	Increasing (70)	Increasing (4)
Tertiary industry change (1990-2000)[16]**	Decreasing (-10)	Decreasing (-68)	Decreasing (-14)
River area (ha)	166	692	28
Municipalities covered	Tomioka-shi, Annaka-shi, Shibukawa-shi, Choufu-shi, Higashikurume-shi, Tsurugashima-shi, Toda-shi, Ichikawa-shi, Sakado-shi, Nerima-ku, Shinagawa-ku, Itabashi-ku, Toshima-ku, Setagaya-ku, Kita-ku, Urayasu-shi	Oota-shi, Kodaira-shi, Yamato-shi, Narashino-shi, Chigasaki-shi, Hino-shi, Kawaguchi-shi, Kamakura-shi, Sano-shi, Kawagoe-shi, Oyama-shi, Narita-shi, Sagamihara-shi, Fujioka-shi, Takatsu-ku, Kumagaya-shi, Takasaki-shi, Maebashi-shi, Hachioji-shi, Iwatsuki-shi, Honjo-shi	Kawasaki-ku, Tsurumi-ku, Kanagawa-ku, Kanazawa-ku, Totsuka-ku, Nka-ku, Kounan-ku, Midori-ku, Izumi-ku, Fujisawa-ku

Note: *Small area - 0-4,211 ha; Medium area - 4,212-12,695 ha; and Large area - 12,696-58,157 ha; (number in brackets) - number of counts
**Primary, secondary, and tertiary industry refers to the number of population working in each of these industries

provision among small, medium and large areas for promoting urbanization (refer to **Table 3**). Post hoc Tukey HSD test indicates that the importance of storm and flood protection in small urbanization promotion area is significantly different among small, medium, and large areas. Games Howell post hoc test on the importance of food provision shows that small area also differs significantly from medium urbanization promotion area.

Importance of storm and flood protection shows a negative relationship with gross planted area, meaning the smaller the area, the higher is the importance of storm and flood protection. Smaller gross planted area tends to give more importance to storm and flood protection because there is a limited number of trees and other vegetation in this area which can consume and intercept rain to prevent overflowing water as compared with the medium and large areas. The greater the number of trees, the greater is the ability to prevent flood.

Then again, importance of food provision is positively related with gross planted area. This means that the bigger the area, the greater is the importance of food. Japanese people are now showing great concern over the future food supply in Japan so it is important to increase domestic agricultural production as much as possible in order to secure a stable food supply.

c) Land-use changes

Changes in land-use and land cover affect ES either in positive or negative way. Agricultural land use and urban land use data from 1970-1990 were obtained from the Ministry of Agriculture[15]. The negative values were recoded into "decreasing", zero values into "no change", and positive values into "increasing" land-use (refer to **Table 4**). The one-way ANOVA shows that in agricultural land-use change, there is a difference in the importance given to water supply in decreasing land-use compared with no change in land-use. Decreasing agricultural land-use area decreases the importance of water supply as compared with no change in land-use. The smaller the area for agricultural purposes, the lesser is the consumption of water for the crops, trees, and other vegetation. Hence the slighter the need for water, the smaller its importance becomes.

In urban land-use change, a statistically positive difference also resulted between the importance of water supply in no change and increasing urban area. As urban area increases, so is the need for water supply as shown by the means (**Table 3**). As the population increases along with an increasing urban area, the greater is the demand for water.

(5) Modeling E-QOL

Simultaneous multiple regression was conducted to investigate the predictors of general satisfaction as shown in **Table 5**. The combination of the variables to predict general satisfaction included importance and satisfaction with the nine ES. All the importance and satisfaction values of the nine ES were inputted into model at the same time. The model was statistically significant F(18,137) = 3.18 (p<0.01). The R squared value was .295 - meaning the model can explain 29.5% of the variance in general satisfaction. At p <0.20, the importance of water pollution control and satisfaction with air pollution control, which were highlighted in bold in **Table 5**, significantly predict the general satisfaction (E-QOL) but this result is not robust.

(6) Implications for urban planning

From AGA analysis, results show ES that should be the prioritized to increase E-QOL are heat island mitigation, air pollution control, green house gas reduction, and water pollution control. It is important to know which are the sources and if quantity, quality, and accessibility could affect these four identified priority ES to be able to increase E-QOL.

Studies of Bolund and Hunhammar (1999)[17] and Yan and Matsuzaki (2003)[18], showed that the different natural ecosystems identified as possible sources of ES in the urban areas are street trees, parks, urban forests, trees in residential areas, cultivated lands including farmlands and paddy fields, open spaces, grasslands, and streams. These were included in the survey questionnaire and the respondents were asked about the probable sources of each of the ES. Based on their answers, for heat island mitigation, the sources are street trees, forests, residential trees, and parks. For greenhouse gas reduction, the sources are street trees, forests, and residential trees. For air pollution control, the sources are street trees and forests and for water pollution control, the forests. For air pollution control, heat island mitigation and greenhouse gas reduction, the quantity of ES are important while for water pollution control, the quality is important.

The quantity and the quality of the forests could be improved to possibly increase E-QOL. The number of street trees, residential trees, and parks could be increased as well.

The result multiple regression analysis shows that E-QOL is positively related to importance of water pollution control and satisfaction of air pollution control. This implies that to most likely increase E-QOL, it is necessary to increase the source of these ES.

4. CONCLUSION AND FUTURE STUDIES

This paper aimed to assess the E-QOL using the relationship between importance and satisfaction by AGA analysis, as well as to formulate a model on how to predict it. The Kanto region was chosen as the study site and survey questionnaires were sent to three universities in that region. A total sample of 167 undergraduate students answered the survey. Most of the respondents are under 24 years old and reside in the urban area. There are more male compared to female respondents.

The result of the AGA analysis shows that the priority ES in the urban area almost certainly are air pollution reduction, heat island mitigation, green house gas reduction, water supply, and water pollution control. As a result, it is important to improve the quantity and the quality of the sources of these four ES to possibly increase E-QOL. The model shows that E-QOL could be predicted by importance of water pollution control and

Table 5 Simultaneous multiple regression analysis summary for importance and satisfaction with the nine ES predicting E-QOL

Variable	Importance			Satisfaction		
	Unstandardized Coefficients B	t-value	Significance	Unstandardized Coefficients B	t-value	Significance
Air pollution control	.011	.212	.832	**.190**	**1.788**	**.076***
Heat island mitigation	.028	.622	.535	.101	.834	.405
Green house gases reduction	-.019	-.411	.681	.003	.024	.981
Storm and floods protection	-.021	-.480	.632	.102	1.125	.262
Water supply	-.004	-.077	.939	.013	.119	.905
Water pollution control	**.078**	**1.199**	**.136***	.076	.653	.515
Recreation	.031	.531	.596	.105	1.198	.233
Food provision	-.013	-.275	.784	.190	.898	.371
Habitat provision	.023	.518	.605	.101	.479	.632
Constant	.116	.102	.919			

Note: R^2=.295; F(18,137)=3.18, p<0.01; *significant at p<0.20

satisfaction with air pollution control.

There is also some limitation during the data gathering because most of the respondents were young students in the urban area. Hence, data from semi-urban and rural areas in the Kanto region should be collected as well to compare with the result of this study. Kanto region residents, not only students, with different jobs, and other age groups should be chosen as respondents as well.

Factors used in differentiating the importance and satisfaction are urban promotion area, gross planted area, and land-use changes. Historical changes could also have an impact in the analysis of E-QOL so these must be studied as well.

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