【研究ノート】

Development of a Web-Based Personal Ecological Footprint Calculator for Japanese Consumers: Facilitating a Sustainable Lifestyle in accordance with "One Planet Living"

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1 Introduction

1. 1 Problem Statement

Nowadays, an increasing number of Japanese citizens recognize the importance of ecological sustainability. They are aware that ecological degradation and the depletion of natural resources are becoming more and more serious due to humanity's heavy dependency on the natural environment.

On the other hand, they do not necessarily understand how their everyday consumption is connected to the destruction of the natural environment, and by how much. Furthermore, it is not easy for them to generate concrete action plans toward a substantial reduction in their ecological impact. The authors realized that

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there was a need for ways to facilitate transforming their emotional concerns into visible action.

With this understanding of the current situation in Japan, we tried to develop a user friendly computer-based calculation tool to assist the transition among citizens in Japan. More concretely, we have developed a computer-based and internet web-based personal Ecological Footprint (EF) calculator. We have conducted some pilot studies using the calculator. The results will be briefly discussed in the latter part of this paper.

1. 2 Purposes

This paper describes how the authors have developed a computer-based personal Ecological Footprint calculator. This calculator was designed to assist the Japanese citizens in realizing the magnitude of their dependency on the carrying capacity of the global ecosystems. We have built a user-friendly interface, i.e., a questionnaire style calculator. It was uploaded on the internet web-site of an NPO, Ecological Footprint Japan, in May 2007 (http://www.ecofoot.jp/quiz/index.html). The ultimate purpose is to provide Japanese residents with concrete numerical targets for reducing their own Ecological Footprint. We trust that with the assistance of this calculator as a sustainability indicator, citizens will be able to achieve sustainable lifestyles more effectively than just depending on emotions and vague dreams for becoming more sustainable.

1. 3 Uniqueness

Several similar tools have been developed and are being used in other countries. For example, Earth Day Network (USA) has put up a web-based personal calculator (http://www.earthday.net/footprint/index.asp). This calculation tool can reflect the differences in terms of where you live, and how your lifestyle is. However, local

conditions are not fully incorporated. Also, this calculator often offers rather vague and 'qualitative' questions and answers. Thus, it is likely that answers may be distorted depending on the respondent's subjective interpretation of the words in the questions and answer choices.

In order to overcome these shortcomings, we have tried to design a tool which is more sensitive to the characteristics of the Japanese consumption patterns. We have also tried to reflect the degree of environmental consciousness which is imbedded in the everyday lifestyle of each respondent. In addition, we have attempted to provide as many 'quantitative' questions and answers as possible, in order to reduce the biases from individual's subjective interpretation of the words in them.

1. 4 Rational and Expected Results

These days there are a number of indicators for monitoring ecological sustainability. However, Ecological Footprint is one of the very few well-recognized sustainability indicators which can relate human demand on nature to the carrying capacity of the earth ecosystems. Through the lenses of Ecological Footprint, we can compare our dependency on and demand for natural services with the supply capacity of the global ecosystem (Wackernagel & Rees, 1996; Rees, 2000). This is possible in terms of various levels, such as global, national, regions, cities, communities, individuals and products. There have been a number of applications of this indicator on these levels (Chambers et al., 2000; Collins et al., 2005; Wiedmann & Barrett, 2005; Moore et al., 2007). Ecological Footprint can express our consumption in terms of how many 'planets' we require. One of the necessary conditions for ecological sustainability is whether we achieve 'One Planet Living' (BioRegional, 2007).

According to Global Footprint Network (GFN, 2005), the Japanese per capita

Ecological Footprint is 4.27 global hectares (gha) in 2002 (see Table 1). That is 2.3 times as large as the world per capita biocapacity. Also, the total Japanese Ecological Footprint (EF) is 5.7 times as large as the total area of the Japanese terrestrial territory and surrounding continental shelves. These figures show that the Japanese consumption patterns cannot be extended to other countries in the world, if we thrive to be truly sustainable ecologically on a global context.

Furthermore, we disclose the Japanese average consumption data (see Table 3), that will make the respondents aware of which consumption categories they should reduce in order to make their lifestyle more sustainable.

In the future, we would like to develop similar calculators for the use of local autonomies, companies, and NPOs.

2 Procedure for Developing a Calculator

2. 1 Data Preparation for EF Calculation (see Table 2 and Table 3)

2. 1. 1 Consumption Categories and Corresponding Land Categories

Consumption Categories for this calculation tool are basically the same as the 'Consumption Land Use Matrix' constructed by the Global Footprint Network (GFN). We have divided national consumption into five large categories (1: food, 2: Housing, 3: Goods & Services, 4: Transportation, and 5: Unclassified). Then, we have further divided them into 18 break-down categories, each of which is represented by one question (see Table 2 and Table 3; Columns A)). We have included 'Discounting Factors for Environmentally-Conscious Behaviours' (suffixed with * in Table 2). Examples are Questions 4, 12, 17, 18. Question 5 is an adjustment parameter for obtaining per capita floor areas in a house.

We have assigned the corresponding land categories based on GFN's Consumption Land Use Matrix (CLUM) for Japan (Table 3; Column B1). The formula for aggregation of land areas are presented in Table 3; Column B2.

Table 1 Comparison of Japanese Ecological Footprint and Biocapacity

Per capita Japanese Ecological Footprint	a	4.27 gha/cap
Per capita World Biocapacity	b	1.82 gha/cap
Per capita Japanese Biocapacity	c	0.75 gha/cap
How many Earths are needed, if everyone on the Earth lived like an average Japanese?	d = a/b	2.3
How many Japans are necessary to support the current Japanese consumption?	e = a/c	5.7

(Data: Year 2002, GFN 2005).

Table 2 Consumption Categories

Q 1: Meat and Dairy Products
Q 2: Seafood
Q 3: Vegetables, Grains and Fruits
Q 4: Domestic / National Products Ratio *
Q 5: Number of Residents in a House
Q 6: Housing (Floor Area)
Q 7: Electricity Consumption
Q 8: Town Gas
Q 9: Kerosene Fuel
Q10: LPG (and / or Propane Gas)
Q11: Furniture, Home Electric Appliances, Clothes, Cars, etc.
Q12: Reduction of EF by Green Purchases and Recycling, etc.*
Q13: Communication, Medical Care, Recreation, Education
Q14: Ridership on Trains, Buses, and Subways
Q15: Air Travel
Q16: Car Use
Q17: Reduction of EF by Using Energy-Efficient and / or Small Cars *
Q18: Reduction of EF by Multiple Ridership in a Car *

(＊denotes a 'Discounting Factor for Environmentally Conscious Behaviours.')

Table 3　Average Japanese Consumption and its EF by Consumption Category

A : Consumption Categories			B : Land Categories & Sum	
			B1 : Corresponding Land Categories	B2 : Formula
① Food	Meat & Dairy Products	Q1	Cropland, Pasture, Forest	① =Q1+Q2+Q3+Q4
	Seafood	Q2	Fishing Ground	
	Vegetables & Grains, Fruits	Q3	Cropland, Forest	
	Domestic Products Ratio	Q4	Energy Land	
② Housing	Number of Residents	Q5	—	—
	Housing (Floor Area)	Q6	Energy Land, Forest	② =(Q6+Q7+Q8+ Q9+Q10)/Q5
	Electricity	Q7	Energy Land	
	Town Gas	Q8	Energy Land	
	Kerosene (fuel)	Q9	Energy Land	
	LPG (Propane Gas)	Q10	Energy Land	
③ Goods & services	Furniture, Home Electric Appliances, Clothes, Cars, etc.	Q11	Energy Land, Cropland, Forest, Built Area, Fishing Ground	③ =Q11×Q12+Q13
		Q12	Reduction of EF by Green Purchases & Recycling	
	Communication, Medical Care, Recreation, Education, etc.	Q13	Energy Land, Forest, Built Area	
④ Trans-portation	Train, Bus, Subway, etc.	Q14	Energy Land	④ =Q14+Q15+(Q16×Q17×Q18)
	Air Travel	Q15	Energy Land	
	Car Use	Q16	Energy Land, Cropland	
		Q17	Reduction of EF by Using Energy-efficient or Small Cars	
		Q18	Reduction of EF by Multiple Ridership	
⑤ Unidentified			Energy Land, Forest	⑤ =1.101×(①+②+③+④)/(4.301−1.101)

(B1, C1: GFN 2005)

Table 3 (continued.)

C : Average EF by Consumption Category, Average Consumption, EF Intensity				D : References
C1 : Japanese Average EF (gha/cap)	C2 : Japanese Average Consumption (Environmentally-conscious Behaviors)		C3 : EF Intensity (C1/C2)	
	Average Consumption	Explanations		
0.24	400 g/cap/day	Consumption of meat, egg and dairy products	0.06gha/100g/cap/day	Ministry of Agriculture, Forestry and Fisheries (MAFF) 2006
0.37	100 g/cap/day	Consumption of seafood	0.37gha/100g/cap/day	
0.31	866 g/cap/day	Consumption of rice, bread, tofu, soymilk, potatoes, greens, etc.	0.0358gha/100g/ cap/day	
0.08	Half and half local perishable products and rozen, imported fand processed foods	Food self-sufficient rate, eating out & processed food ratio	—	· MAFF 2006, · Pr ime Minister's Office 2003
—	—	—	—	—
0.25	35.2 m^2/cap	Total Floor Area	0.0710gha/10m^2/cap	Ministry of Internal Affairs & Communications (MIC) 2000, 2005
0.3	2,110 kwh/cap/yr	Consumption of Electricity	0.142gha/1,000kwh/cap/yr	· Ministry of Economy, Trade and Industry (METI) 2006 · Energy Data and Modeling Center (EDMC) 2004. · Ministry of the Environment 2004
0.048	82 m^3/cap/yr	Consumption of Town Gas	0.0058gha/10m^3/cap/yr	
0.07	102 Liters/cap/yr	Consumption of Kerosene fuel	0.0690gha/100L/cap/yr	
0.032	38 Kg/cap/yr	Consumption of bottled gas	0.00842gha/10Kg/cap/yr	
0.46	16,767 Yen/cap/month	Disbursement of clothes, furniture, home electric products, cars, etc	0.2744gha/10,000Yen/cap/month	Prime Minister's Office 2003
—	Almost Always Consider Environmental Aspects When Buying Goods	Research Results of Consciousness on Environmental Issues	—	Cabinet Office 2005
0.44	23,882 Yen/cap/month	Disbursement of services	0.1842gha/1,0000/cap/month	Prime Minister's Office 2003
0.03	5.03 km one way/cap/day	Mileage by Railways & Buses	0.00439 gha/km one way/cap/day	MIC 2007
0.07	2.05 hours/cap/yr	Mileage by aviation flight hours & flight distances	0.0341gha/hour/cap/yr	MIC 2007, JAL HP accessed on 2007.4.3.
0.5	5,938 km/cap/yr	Mileage by car	0.0842gha/1,000km/cap/yr	MIC 2007
—	—	Fuel efficiency ratio between normal cars and energy-efficient and / or small cars	—	Green Purchasing Network (GPN), HP accessed on 2007.2.3.
—	—	Multiplel Ridership	—	—
1.101	—	—	—	—

2. 1. 2 Average Ecological Footprint for Each Consumption Category

The Japanese average Ecological Footprint (gha/capita) for each consumption category was obtained from the Consumption Land Use Matrix (CLUM) compiled by GFN in 2005 (Table 3; Column C1). The aggregated EF figure for each land type (namely, Energy Land, Cropland, Pasture, Forest, Built Area, and Fishing Ground) was obtained from such international statistics as IEA, FAO, and GAEZ statistics. On the contrary, breakdown figures within the consumption categories (Food, Housing, Mobility, Goods, Services, and Unidentified) are generic figures for typical industrialized countries; except for the energy consumption (which was Japanese data obtained from IEA statistics).

2. 1. 3 Calculation of Japanese Average Consumption Values for each EF Figure

The next step was to compute the Japanese average consumption for each consumption category, i.e., corresponding consumption volume, mass or monetary value (Table 3; Column C2) for each break-down EF figure. We obtained consumption data from various official governmental statistics (see Table 3 Column D). Next, we have computed the 'EF Intensity' figures ('per capita' gha figure divided by the 'per capita' consumption figure), i.e., dividing C1 by C2.

2. 2 Setting Ranked Ranges for Consumption & Assigning Representative Numbers for Each Range

The following step was to set up ranked ranges of consumption patterns for each question (namely, Q1 through Q18). We have tried to reflect the reality of the Japanese consumption patterns in the process of setting up the ranges. The respondents are asked to choose one out of the five or six given choices (ranges), depending on how much they normally consume per unit period of time. For

Table 4 Representative Numbers (RN) and Ranked Ranges

Items		Representative Numbers (RN) · Answer		Unit	Ranked Ranges					
					①	②	③	④	⑤	⑥
Q1	Meat, Dairy Products	RN	Consumption	g/cap/day	0	75	225	400	600	800
			EF	gha	0	0.045	0.135	0.24	0.36	0.48
		Answer		g/cap/day	None	Less than 150g	150 ~ 300g	300 ~ 500g	500 ~ 700g	More than 700g
Q2	Seafood	RN	Consumption	g/cap/day	0	20	60	100	160	200
			EF	gha	0	0.074	0.222	0.37	0.592	0.74
		Answer		g/cap/day	None	Less than 40g	40 ~ 80g	80 ~ 120g	120 ~ 200g	More than 200g
Q3	Vegetables, Grains, Fruits	RN	Consumption	g/cap/day	433	650	866	1,083	1,732	
			EF	gha	0.155	0.233	0.310	0.388	0.465	
		Answer		Qualitative	Rare	Less than average	Average	More than average	Much	
Q4	Domestic Products Ratio	RN	Rate of Local products	Factor	0.5	0.75	1	1.5	2	
			EF	gha	0.04	0.06	0.08	0.12	0.16	
		Answer		Qualitative	Almost all is fresh and domestic food.	More than half is fresh and domestic food.	Half is fresh and domestic food. Half is frozen, imported and processed food.	More than half is frozen, imported and processed food.	Almost all is frozen, imported and processed food.	
Q6	Housing	RN	Total floor space	m^2/household	25	75	125	175	225	
			EF	gha/household	0.178	0.533	0.888	1.243	1.598	
		Answer		m^2/household	Less than 50m^2	50 ~ 100m^2	100 ~ 150m^2	150 ~ 200m^2	More than 200m^2	
Q7	Electricity	RN	Consumption	kwh/household/month	0	100	250	400	600	800
			EF	gha/household	0.000	0.170	0.426	0.682	1.023	1.364
		Answer		kwh/household/month	None	Less than 200kwh	200 ~ 300kwh	300 ~ 500kwh	500 ~ 700kwh	More than 700kwh
Q8	Town Gas	RN	Consumption	m^3/household/month	0	5	15	30	50	70
			EF	gha/household	0.000	0.035	0.104	0.208	0.347	0.486
		Answer		m^3/household/month	None	Less than 10m^3	10 ~ 20m^3	20 ~ 40m^3	40 ~ 60m^3	More than 60m^3

Table 4 (continued.)

Q9	Kerosene Fuel	RN	Consumption	L/household/ month	0	5	15	30	50	70
			EF	gha/household	0.000	0.041	0.124	0.248	0.414	0.580
		Answer		L/household/ month	None	Less than 10L	10 ~ 20L	20 ~ 40L	40 ~ 60L	More than 60L
Q10	LPG	RN	Consumption	kg/household/ month	0	5	15	30	50	70
			EF	gha/household	0.000	0.050	0.151	0.303	0.505	0.707
		Answer		kg/household/ month	None	Less than 10kg	10 ~ 20kg	20 ~ 40kg	40 ~ 60kg	More than 60kg
Q11	Furniture, Home Electric Appliances, Clothes, Car, etc.	RN	Disbursement	Yen/household/ month	2,500	7,500	15,000	25,000	35,000	
			EF	gha	0.069	0.206	0.412	0.686	0.960	
		Answer		Yen/household/ month	Less than 5,000Yen	5,000 ~ 10,000Yen	10,000 ~ 20,000Yen	20,000 ~ 30,000Yen	More than 30,000Yen	
Q12	Green Purchasing/ Recycling	RN	EF adjustment factor	Factor	0.75	1	1.25	1.5		
		Answer		Qualitative	Always	Often	Not Very Often	Never		
Q13	Communication, Medical Care, Recreation, Education, etc	RN	Disbursement	Yen/household/ month	5,000	15,000	25,000	35,000	45,000	
			EF	gha	0.092	0.276	0.461	0.645	0.829	
		Answer		Yen/household/ month	Less than 10,000Yen	10,000 ~ 20,000Yen	20,000 ~ 30,000Yen	30,000 ~ 40,000Yen	More than 40,000Yen	
Q14	Train, bus, subway	RN	Mileage	km one way/ cap/day	0	1.5	4	7.5	17.5	32.5
			EF	gha	0.000	0.007	0.018	0.033	0.077	0.143
		Answer		km one way/ cap/day	None	Less than 3km one way	3 ~ 5km	5 ~ 10km	10 ~ 25km	More than 25km
Q15	Air Travel	RN	Flight hours	hours/cap/yr	0	1.25	3.75	7.5	20	40
			EF	gha	0.000	0.043	0.128	0.256	0.683	1.366
		Answer		hours/cap/yr	None	Less than 2.5hours	2.5 ~ 5hours	5 ~ 10hours	10 ~ 30hours	More than 30hours
Q16	Car	RN	Mileage	km/cap/yr	0	1,250	3,750	6,000	8,500	11,500
			EF	gha	0.000	0.105	0.316	0.505	0.716	0.968
		Answer		km/cap/yr	None	Less than 2,500km	2,500 ~ 5,000km	5000 ~ 7,000km	7,000 ~ 10,000km	More than 10,000km

Table 4 (continued.)

Q17	Energy-Efficient car, Small Car	RN	EF adjustment factor	Factor	1	0.75	0.5			
		Answer		Qualitative	None	Sometimes	Very often			
Q18	Number of Passengers	RN	EF adjustment factor	Factor	1	0.5	0.33			
		Answer		cap	1	2	More than 3			

example, Question 2 asks how much fish and shellfish do you eat each day? And we offer the following six choices in ranges. (1): zero, (2): less than 40 grams, (3) more than 40 grams and less than 80 grams, (4) more than 80 grams and less than 120 grams, (5) more than 120 grams and less than 200 grams, and (6): more than 200 grams. We also offer typical mass or volume information for each category in order to assist respondents in answering the questions. For example, the calculator displays "Typically a fillet of fish weighs 70-100 grams."

Then, we have assigned a representative number (RN) for each range. (See Table 4). The RN is expressed in terms of both consumption mass/volume and Ecological Footprint. The representative number (RN) for the Ecological Footprint for each range was computed by multiplying the RN of consumption mass by the EF Intensity figure.

2. 3 Setting 'Environmentally-Conscious Behaviour Factors'

We have assigned three, four, or five choices for 'factors of environmentally-conscious behaviours' in each of four questions (namely, Q4, Q12, Q17, and Q18) (See Tables 2 and 4). For these parameters, we are only able to use 'qualitative' questions (except for Q18). For example, Q12 states: Do you choose environmentally-conscious products? Do you try to use long-term durable products? Do you recycle goods after use? Answers to this question are: (1) Always, (2) Often, (3) Not Very Often, and (4) Never. We have assigned factors to above respective

Example of the Question Page

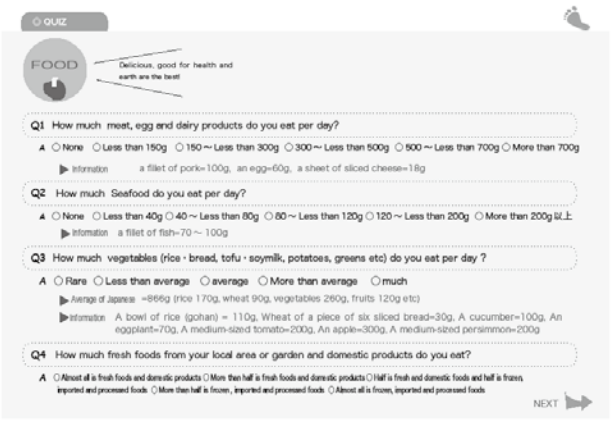
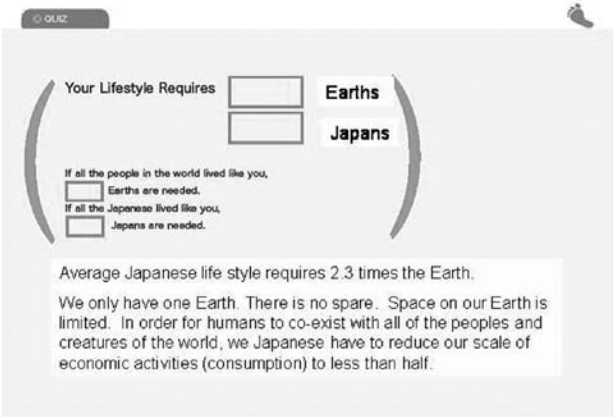


Figure 1　Example of the Question Page



Web-site address: http://www.ecofoot.jp/quiz/index.html

Figure 2　The Last Page of the EF Quiz: Results

answers. Corresponding factors are: (1) 0.75; (2) 1.00; (3) 1.25; and (4) 1.50. Q18 asks, 'How many persons usually ride in your care (including you)? Answers are: (1) 1; (2) 2; and (3) more than 3.

2. 4 Designing a Quiz Page (See Figures 1 and 2)

Using the above data and information, we have designed questionnaire pages.

We added typical mass or volume information for each question in order to assist respondents in answering the questions. For example, Within Q2, the calculator displays "Typically a fillet of fish weighs 70 grams-100 grams."

At the end of the quiz, the calculator how many planets would be necessary if all the people in the world lived like the respondent, and how many Japans would be required if all the people in Japan lived like he/she does.

3 Pilot Studies

We have conducted pilot calculations, and the results seem to be reasonable.

3. 1 Case Study in Tokyo

We were able to obtain answers from eight respondents who live in the suburban areas of the Tokyo Metropolitan Region between February and April, 2007 (see Table 5). Those respondents are: one university student (male), two junior engineers (male and female), one senior engineer (male), one NPO staff (female), one house-wife (female), and two retired engineers (both male). Calculation results ranged between 1.50 gha/capita and 4.99 gha/capita. The average of eight figures was 3.22 gha/capita. Surprisingly, the male university student scored the largest, i.e., 4.99 gha/capita. His EF figures in 'food,' 'goods & services,' and 'housing' seem to be the largest contributing categories.

On the contrary, the smallest footprint turned out to be the house-wife's. Her personal EF figure was only 1.5 gha per person. She had already achieved 'One

Table 5　Preliminary Study: Calculation Results of Eight Respondents in Tokyo

Items		Japanese Average	Average of the 8 respondents	Univ. student (m)	Junior Engineer (m)	Junior Engi neer (f)	Senior Engineer (m)	NPO staff (f)	Housewife (f)	NPO, retired engineer (m)	NPO, retired engineer (m)
Food		1.00	0.70	0.97	0.83	0.56	0.98	0.47	0.43	0.60	0.73
	Domestic Products Ratio			Half is fresh and domestic food. Half is frozen, imported and processed food.	More than half is fresh and domestic food.	More than half is fresh and domestic food.	Almost all is frozen, imported and processed food.	Almost all is fresh and domestic food.	Almost all is frozen, imported and processed food.	Almost all is frozen, imported and processed food.	More than half is fresh and domestic food.
Hou sing	Number of Residents (persons)	2.59	3.50	3	3	2	4	2	6	6	2
		0.70	0.62	1.03	0.47	0.28	0.44	0.96	0.38	0.38	1.00
Goods&Services		0.90	0.80	1.49	1.06	0.35	0.87	0.69	0.30	0.69	1.00
	Green Purchasing / Recycling			Never	Often	Not Very Often	Often	Often	Often	Often	Always
Transportation		0.60	0.28	0.22	0.86	0.10	0.69	0.23	0.01	0.06	0.06
	Energy-Efficient car, Small Car			Sometimes	None	None	None	None	—	—	None
	Number of Passengers	—	1.80	1	More than 3	2	2	2	—	—	2
Unidentified		1.10	0.83	1.28	1.11	0.44	1.03	0.81	0.38	0.59	0.96
Total EF		4.30	3.22	4.99	4.34	1.73	4.00	3.16	1.50	2.32	3.74
No. of Earths		2.3	1.8	2.7	2.4	1.0	2.2	1.7	0.8	1.3	2.1
Comparison with Japan Average		—	0.75	1.16	1.01	0.40	0.93	0.73	0.35	0.54	0.87

(EF Unit: gha/cap; f: female; m: male)

Planet Living' or to be more precise, '0.8 Plant Living.' She stays home for most of the time, except that she is sometimes engaged in volunteer activities outside home. She often chooses walking and bicycling as her transportation modes. As a result, her transportation EF figure was very small (0.01 gha per person). This housewife and one female junior engineer were the ones whose per capita EF turned out to be lower than the per capita global biocapacity (BC). This is good news, because this means that a person can live an ecologically sustainable life even within a high-income industrialized country, i.e. Japan if one chooses to do so.

Two of them had EF values which were above Japan average. Six of them were above per capita global biocapacity. Three were above the Japan average in 'housing,' and 'goods & services.' All were below the Japanese average in 'food.' Seven were somewhat engaged in 'green purchasing,' and recycling. Six were below the Japanese average in 'transportation.' This may be due to the fact that the Tokyo Metropolitan Region is equipped with extended web of efficient public transportation modes including trains, subways and buses.

3. 2 Case Study in Kyoto

Another case study was conducted at Doshisha University in Kyoto between June and July in 2007. We were able to obtain 167 valid answers. The respondents were mostly the second year students majoring in economics. Among those, 115 were male students and 52 were female students. There were 78 single dwellers and the remaining 89 lived with family (See Table 6 and Figure 3). 62 males were single dwellers and 53 males lived with family. Female single dwellers were smaller in number (16) and the rest 36 lived with family members.

The average EF figure (3.26 gha per person) turned out to be smaller than the Japanese average (4.30 gha per person). The average for male students was 3.09 gha per capita. The one for female students was 3.65 gha per capita, which was

Table 6　Preliminary Case Study: Doshisha University Students (Kyotanabe Campus) in Kyoto

	Japanese Average EF	Average of the 167 Respondents	Male and Female Comparison		Single Dweller or Living with Family	
			Male	Female	Single Dweller	Living with Family
EF Value (gha/capita)	4.30	3.26	3.09	3.65	2.91	3.57
How many Planets	2.4	1.8	1.7	2.0	1.6	2.0
Comparison against the Japanese Average	—	0.76	0.72	0.85	0.68	0.83

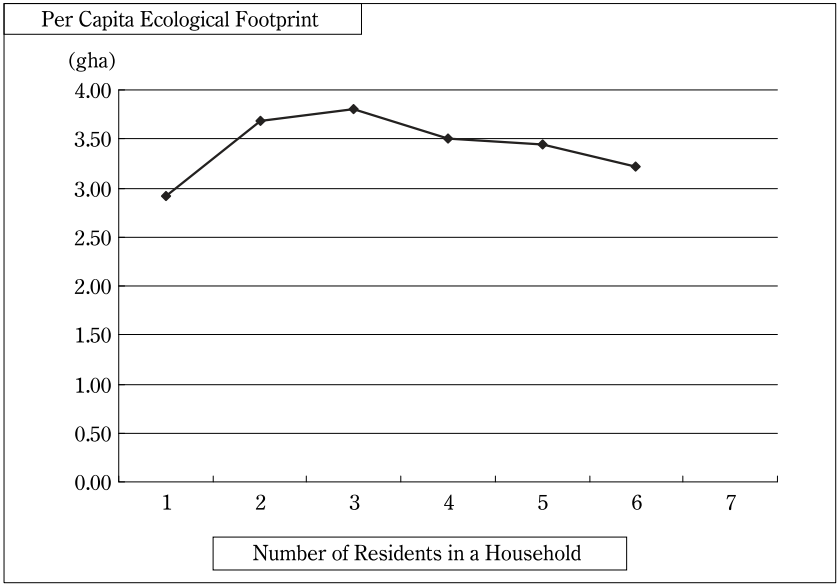
(Survey conducted between June and July 2007)

Table 7　Comparison of Consumption between Male and Female Students

	Average of Male (m)	Average of Female (f)	f/m
Goods and Services	12,900 (Yen/month)	20,500 (Yen/month)	159%
Air Travel Hours	1.82 (hour/year)	3.94 (hour/year)	217%
Public Transportation	15.6 (one way, km/day)	20.1 (one way, km/day)	135%
Automobile Use	1,630.4 (km/year)	2,331.7 (km/year)	143%

significantly larger than the male average.

The difference between the male and female averages was 0.56gha per capita. Detailed analysis has not been completed yet. However, it would be safe to infer that more consumption of at least four consumption categories contributed to the larger EF figures for female students, i.e. (1) more expenditure for 'goods & services'; (2) longer air travel hours; (3) more dependence on public



(The number of total valid responses: 165. Two responses were excluded since those appeared to be outliers.)

Figure 3 Relationship between the Number of Residents in a Household and Per Capita Ecological Footprint

transportation; as well as (4) more use of automobiles (see Table 7).

Single dwellers had smaller EF figures than those who live with family members (2.91 gha per capita and 3.57 gha per capita respectively. The gap between the two was 0.66 gha per capita which was larger than the gap between male and female averages.

Figure 3 shows that the 'economy of scale' seems to become dominant only if the size of the family becomes larger than three. This is somewhat counter-intuitive.

Respondents were requested to provide comments after participating in the

questionnaire. Most of them presented positive comments. One typical comment was that answering the questions was a valuable exercise because they were able to realize how much impact was being imposed onto the ecosystems due to their consumption patterns. This personal EF calculator seems to provide excellent opportunities to the Japanese students and consumers to reflect upon their own lifestyles through visualizing their ecological dependencies in terms of Ecological Footprints.

4 Conclusions and Directions for Further Study

4. 1 Conclusions

We have developed a computer- and internet-based personal EF calculator for use by Japanese people. This tool enables them to assess how much ecological service and resources their lifestyle is dependent on. The consumption categories and parameters for environmentally-conscious behaviours are based on GFN's Consumption Land Use Matrix (CLUM). We also obtained data from consumption statistics from the Japanese government and international statistics. The Japanese consumption was divided into six large categories and eighteen breakdown categories.

We have provided five or six ranges in each consumption category. We, then, have assigned a representative number (RN) for each range in terms of both consumption mass/volume and Ecological Footprint.

We also have provided typical mass or volume information of each category. For example, we provided a phrase, "One bowl of rice typically weighs 110 grams."

We have made conscious effort to make the quiz sensitive to environmentally-conscious efforts. We have assigned three, four, or five choices for 'factors of environmentally-conscious behaviours' in each of four questions (i.e., Q4, Q12, Q17, and Q18). We have also attempted the quiz to be simple enough for ordinary

citizens.

4. 2 Directions for Further Study

4. 2. 1 Accuracy Improvement

As of now, such consumption categories as housing and services do not have 'Environmentally-Conscious Behaviour Factors.' We trust that adding these parameters to these consumption categories will make the EF calculation more accurate and reliable.

In our society, there are many kinds of goods and services. However, the goods and services sectors in our quiz are still very broad. We feel that it is necessary to provide more detailed breakdown categories in order to improve accuracy.

4. 2. 2 Reassessment of the tradeoff between simplicity and accuracy

It is important that the quiz is simple enough for ordinary citizens to be willing to participate in the quiz. Otherwise, this quiz will not be used by a wide-range of people. On the other hand, accuracy is also important. It is important for us to reassess the tradeoff between the two.

In terms of quantitative questions, respondents need to keep records of his/her consumption figures. So, only conscientious and 'willing' people may be able to take an advantage of this tool.

4. 2. 3 Information on How to Reduce Footprint

It would be useful for respondents to have access to the information on how much reduction in EF figures would be brought about through their concrete behaviour changes. Thus, within the quiz, we would like to provide information columns regarding the concrete action scenarios (menus) for EF reduction, accompanied by the corresponding expected results.

4. 2. 4　Tools for Local Authorities and Companies

In the future, we would like to develop similar calculators for the use of local autonomies, companies, and NPOs. The Resources and Energy Analysis Programme (REAP) developed by the Stockholm Environment Institute York (SEIY) seems to be a good model for this kind of tool (Wiedmann & Barrett, 2005).

4. 2. 5　Statistical Analyses of the EF for Different Social Groups

The authors are planning to conduct statistical analyses of Ecological Footprint for various social groups in Japan. This personal EF calculator will be employed as a data collection device. A possible candidate group would be university students. It would be interesting to compare the EF figures between male and female students, single dwellers versus those who live with his/her own family, or students who have taken courses on environmental and resource issues versus those who have not. Not only university students, but also elementary and high school students should be ideal candidates. It would be interesting to analyse if there is any difference depending on the degree of environmental consciousness/awareness of their homeroom teachers and/or their parents.

Also, it would be valuable to compare the EF calculation results of different income classes or religious groups, or age groups. The same analyses would be beneficial to illuminate regional differences.

The results of these statistical analyses would provide policy and educational implications toward creating 'One Planet Economy.' Not only that, through these studies on a large scale, a number of Japanese citizens will have the opportunity of actually using the personal EF calculator, which would facilitate them to alter their lifestyles toward more sustainable ones.

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Abstract

Yoshihiko WADA, Koji IZUMI, Takahiro MASHIBA, and Xiaohui WANG, *Development of a Web-Based Personal Ecological Footprint Calculator for Japanese Consumers: Facilitating a Sustainable Lifestyle in accordance with "One Planet Living"*

The authors have developed a computer- and internet-based calculator that can assess the demand of Japanese individuals for ecological services and natural resources in terms of their Ecological Footprint (EF). This personal calculator was designed as an environmental education tool to help Japanese citizens in realizing the degree of their dependency on the carrying capacity inside and outside their country. The ultimate aim of this calculator is to suggest scenarios to reduce their own EF by altering their lifestyles. The tool is sensitive to the characteristics of general Japanese consumption patterns as well as the individual traits of each respondent. Personal parameters include individual consumption behavior and willingness to engage in environmentally responsible activities such as buying locally grown and non-processed foods, choosing energy- and resource-saving devices, and choosing sustainable modes of transportation. Some preliminary case studies involving Japanese citizens and university students were conducted to test the validity and usefulness of this calculator. It appears that this tool will be able to influence the lifestyles of Japanese citizens and contribute to achieving the "One Planet Living" goal in Japan.