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Consumer goods in Japanese elderly-only household units: Micro-material stock and earthquake resistance

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Abstract

This study aimed to investigate the actual existential scenarios of consumer goods possessed by people, specifically earthquake resistance of consumer goods in elderly-only households. A 'basic unit' of consumer goods focusing on elderly-only household units was developed in this study. A web questionnaire survey was conducted for household units in the Kansai region of Japan for inhabitants over 65 years of age. The principal questions were related to the quantity and type of consumer goods possessed and/or not used on a daily basis (unnecessary consumer goods). The results of the survey revealed that the total micro-material stock in household units was 1,216 kg/housing unit. The average quantity of unnecessary consumer goods was 20.9%, and the average rate of earthquake resistance for all consumer goods was 35.4%. Case studies in two cities, Minami-Ise and Kobe, were conducted to estimate the quantity of potential disaster waste. In Minami-Ise, the potential disaster waste derived from consumer goods (12,400 t) is equivalent to 83% of the micro-material stock derived from consumer goods in the city; 54% of the disaster waste may be generated from household units alone. The results revealed that if the rate of earthquake resistance of consumer goods was 100%, 22.5% of the potential disaster waste may be reduced. The potential disaster waste derived from consumer goods was estimated at 430,000 t in Kobe. Areas with particularly prominent potential disaster waste derived from elderly-only household units were visualized using GIS.

Keywords

Micro-material stock; consumer goods; elderly household units; disaster waste; earthquake resistance

Abbreviations

COGJ; Cabinet Office, Government of Japan

GIS; Geographic Information System

JMIAC; Japan Ministry of Internal Affairs and Communications

JMOE; Japan Ministry of Environment

1. Introduction

Natural disasters cause significant damage to society. Earthquakes, in particular, cause property damage and associated disasters, such as liquefaction and tsunamis. For example, the 2011 Great East Japan Earthquake brought unprecedented damage to East Japan, with approximately 19,600 deaths, 121,800 destroyed buildings, and 20 million tons of disaster waste [1]. Based on experiences from the Great East Japan Earthquake, the Japanese government has adopted a policy for developing resilience-oriented cities [2].

Disaster waste consists of both solid and liquid waste, such as concrete, steel from damaged buildings and infrastructures, and household furnishings, generated from a disaster [3]. To promote resilience-oriented cities, consideration of disaster waste management as a planning tool before the occurrence of natural disasters is crucial for local governments. Without such planning, a significant amount of disaster waste may be generated by natural disasters, which often hinders recovery and reconstruction processes post the occurrence of disasters. Removing and treating disaster waste, including recycling, is critical [4]. Thus, estimating the quantity of potential disaster waste is a high priority. Originally, in cities, such estimations are done by investigating the anthropogenic stock, such as buildings and consumer goods, which can be classified into two categories: macro-material stock and micro-material stock. The former includes infrastructure and buildings, and the latter includes appliances, furniture, clothes, bags, and similar items. The micro-material stock is usually stored in housing units as consumer goods. Estimating the amount of potential disaster waste prior to a natural disaster is the first step toward disaster waste management [5], [6]. A popular method for estimating the type and amount of potential disaster waste is to calculate the basic unit of disaster waste generated per housing unit and to extrapolate the quantity of total disaster waste generated by multiplying the basic unit with the damage functions. The damage functions can be determined by the type and degree of damage caused by the natural disaster. Methods for estimating potential disaster waste using the damage functions include those based on the amount of actual damage caused after the disasters [7–14] and those that estimate the potential disaster waste before the occurrence of a natural disaster [4, 15–18]. The latter method is based on estimating the amount of anthropogenic stock accumulated in cities.

The amount of potential disaster waste is estimated by overlaying the amount of anthropogenic stock in cities and the degree of damage caused by natural disasters (Figure 1). Studies have been in which the anthropogenic stock in countries and cities were estimated [19–26]. Knowledge obtained from these studies can be used to estimate potential disaster waste. However, in an aging country like Japan, the dwellings and lifestyles of the general public and the elderly might vary greatly across the country. The amount of consumer goods possessed by residents may also depend on the age group. Based on this assumption, to estimate the amount of potential disaster waste, the basic unit must be estimated by considering the age group of the residents. In a previous study [18], the amount of micro-material stock was estimated based on the type of dwelling/consumer goods possessed by the Japanese residents. However, few studies have examined the type of consumer goods possessed by residents based on age group.

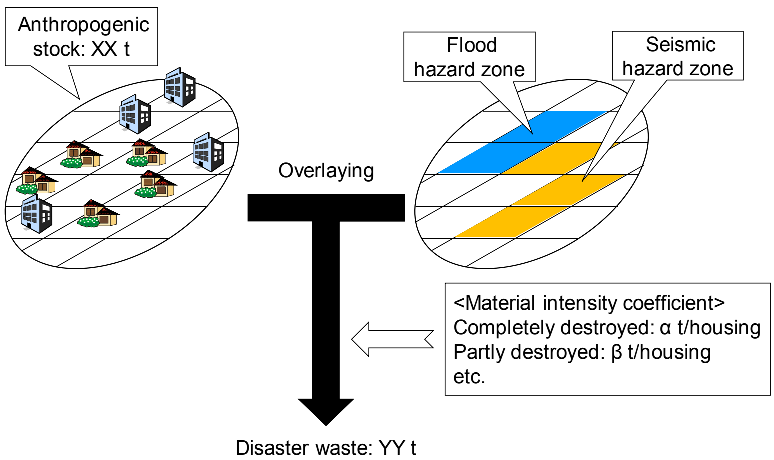

Figure 1 Schematic of disaster waste generation derived from anthropogenic stock

The relationship between earthquake-resistant buildings and infrastructure cannot be neglected for potential disaster waste estimation. COGJ [27] identified the key role of earthquake-resistant buildings in disaster prevention and mitigation. In Japan, construction and renovation of buildings that meet the seismic standards have been conducted based on the building standards law [28]. Earthquake resistance is also effective from the perspective of disaster waste prevention.

For example, Tabata et al. [29] revealed that renovating flood-prevention facilities might reduce tsunami damage, and such measures constitute approximately 10% of disaster waste reduction. When considering household units as a whole, methods to increase resilience included improving earthquake-resistant housing and consumer goods. The practical meaning of earthquake-resistant consumer goods refers to anchoring consumer goods, such as TV sets and chests to avoid falling in the event of an earthquake [30–32]. For this reason, earthquake resistance of consumer goods might also be effective for reducing disaster waste in housing units. This would also reduce property damage and personal injury caused by falling consumer goods. In several countries, including Japan, the number of household units in which only the elderly lived has increased [33]. Elderly citizens generally have reduced physical and cognitive functions [34] and, therefore, may be more susceptible to falling consumer goods than the younger population [35]. To avoid elderly residents from undergoing personal injuries due to falling of objects, the condition of earthquake-resistant consumer goods, specifically in household units, must be known. Although several previous studies on earthquake-resistant buildings and materials have been performed [36], few studies have focused on earthquake-resistant consumer goods in household units.

This study aimed to investigate the actual situation of possessed consumer goods and the earthquake resistance of these goods in elderly-only households and analyzed the quantity of consumer goods and how they differ from regular household units with the help of a questionnaire survey. A basic unit of consumer goods focused on elderly-only households was created in this study. Case studies in two cities (Minami-Ise and Kobe) were conducted to estimate the potential disaster waste derived from consumer goods for household-only units.

2. Materials and methods

2.1. Questionnaire survey

A web questionnaire survey was conducted for household units in the Kansai region of Japan, whose residents consisted only of individuals aged 65 years and above. The Kansai region includes Greater Osaka, the second largest metropolitan area in Japan after Greater Tokyo, and includes six prefectures, namely Osaka, Kyoto, Hyogo, Shiga, Nara, and Wakayama. According to the national census conducted in 2015, the population of the Kansai region was approximately 20.83 million [37] and represented 16.3% of the total population of Japan. The survey was commissioned to a research company specialized in questionnaires for the elderly. Two hundred and twenty residents responded to the survey that was conducted from May 29 to June 7, 2019. The outline of the questionnaire survey is presented in Table 1.

Table 1 Outline of the questionnaire survey

(i) Questions about respondents: Sex, age group, number of household units including respondents, annual income of household
(ii) Questions about housing: Type of dwellings (detached housing, housing complexes, and miscellaneous), construction type (wooden and not wooden), possession of housing (own, rental, and other), construction period (before 1959, 1960–1969, 1970–1979, 1980–1989, 1990–1999, 2000–2009, after 2010, and unknown), total floor area (<29 m^2, 30–49 m^2, 50–69 m^2, 70–99 m^2, 100–149 m^2, >150 m^2, and unknown) and residence years (less than 1 year, 1–5 years, 6–10 years, 11–20 years, 21–30 years, and 31 years or more)
(iii) Possession of consumer goods (22 types): Total, necessary and unnecessary (1) Gas stoves and IH cooking heaters, (2) Refrigerators, (3) Dishwashers, (4) Microwave ovens, (5) CRT TV sets, (6) Flat TV sets, (7) Dressers (Height <1 m), (8) Dressers (Height 1–1.5 m), (9) Dressers (Height ≥1.5 m), (10) Cupboard (Height <1 m), (11) Cupboard (Height 1–1.5 m), (12) Cupboard (Height ≥1.5 m), (13) Bookshelf (Height <1 m), (14) Bookshelf (Height 1–1.5 m), (15) Bookshelf (Height ≥1.5 m), (16) Miscellaneous Furniture (Height <1 m), (17) Miscellaneous Furniture (Height 1–1.5 m), (18) Miscellaneous Furniture (Height ≥1.5 m), (19) Beds, (20) Table sets, (21) Reception sets, and (22) Study desks and learning desks

(iv) Consumer goods that uses earthquake resistance (22 types)

Yes or no

(v) Why do respondents discard consumer goods and/or not use on a daily basis (unnecessary consumer goods)?

Twenty-two specific categories of consumer goods were included in the questionnaire (Table 1). The author conducted a similar questionnaire survey for the elderly living in the Tama River Basin, Japan. The previous survey was conducted in the same area for residents of all age groups [18]. Although the target age group was different, the previous survey was suitable for comparing consumer goods possessed by household-only units and regular household units. In the previous survey, 97 types of consumer goods were targeted to comprehensively document consumer goods in the house. This survey reduced the number of targeted consumer goods to 22, because answering too many questions is extremely burdensome for elderly respondents. This survey reduced the number of questions to a minimum to reduce the stress on the elderly population taking the survey. To conduct an effective survey, this survey selected 22 types of consumer goods that are physically heavy household items [18]. Consumer goods that are potential risks for property damage and personal injury in the event of a fall due to earthquakes, such as chests and bookshelves, were selected. Respondents were asked if consumer goods were earthquake resistant to examine how many respondents used earthquake-resistant consumer goods.

Earthquake resistance of consumer goods is assumed if consumer goods are anchored to a wall or to other consumer goods that are anchored against falling in the event of an earthquake (Figure 2). The quantity of earthquake-resistant consumer goods present in the house was included in the questionnaire. The question about the quantity of unnecessary consumer goods was included to clarify the number of extra consumer goods in elderly possession to verify the results of an interview survey with a public housing corporation prior to this study that mentioned the elderly having many unnecessary consumer goods. Lifestyle changes throughout life in the house of an elderly person in Japan may produce many unnecessary consumer goods., Japanese families typically own their housing units following marriage or childbirth. Landlords currently purchase consumer goods according to the number of rooms/families. According to a national survey of family income and expenditure, the average number of TV sets and chests in a housing unit in 2014 was 1.9 and 2.4, respectively [38]. The children of these household units move away from their family housing for higher studies at a university after obtaining employment or getting married [39]. Following such life events, consumer goods used by the children might remain in the original housing units. This socio-cultural lifestyle causes consumer goods that the elderly do not use to remain in their household units. A question about why unnecessary consumer goods are not discarded by the elderly from their household units was also asked.

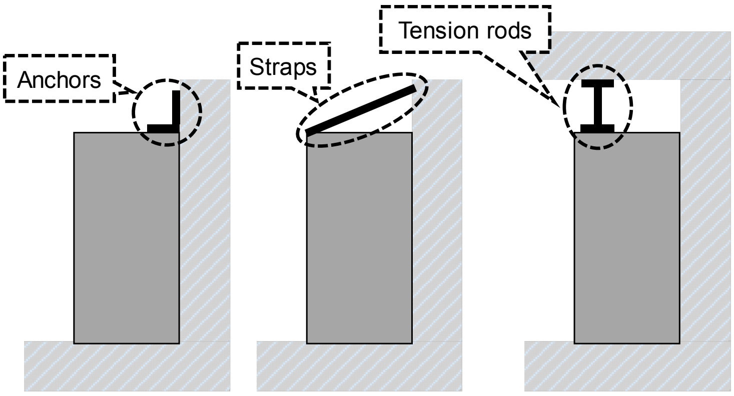

Figure 2 Example of earthquake resistance of consumer goods

2.2. Micro-material stock derived from consumer goods

Based on the results obtained from the questionnaire survey, the amount of consumer goods based on the type of dwelling and total floor area was calculated. Then, the micro-material stock in a house was calculated by multiplying the number of consumer goods by the type of dwellings with the total floor area and basic unit weight of the consumer goods [18]. The formulas are shown below:

$$s^{i}_{d,x} = \sum_{d=1}^{n}\left(P^{i}_{d,x} \times w_d\right) \tag{1}$$

$$S = \sum_{i=1}^{n} \sum_{x=1}^{n}\left(s^{i}_{d,x} \times F^{i}_{x}\right) \tag{2}$$

where s is the micro-material stock derived from consumer goods in a housing [kg], P is the amount of consumer goods [items/household], w is the basic unit of consumer goods [kg/item], d is *the type of consumer goods,* i is the type of dwelling (detached house or housing complexes), x is the type of housing units based on the total floor area of housing, S is the micro-material stock derived from consumer goods in the grid [kg], and F is the number of housing units in the grid.

Micro-material stock derived from consumer goods with earthquake resistance and micro-material stock derived from unnecessary consumer goods are calculated by the following formulas:

$$S^e = \sum_{i=1}^{n} \sum_{x=1}^{n} \left(s_{d,x}^i \times F_x^i \times r^e\right) \tag{3}$$

$$S^u = \sum_{i=1}^{n} \sum_{x=1}^{n} \left(s_{d,x}^i \times F_x^i \times r^u\right) \tag{4}$$

where S^e is micro-material stock derived from consumer goods with earthquake resistance in the grid [kg], r^e is the rate of earthquake resistance of each of the consumer goods [-], S^u is the micro-material stock derived from unnecessary consumer goods in the grid [kg], and r^u is the rate of unnecessary consumer goods [-].

The rate of earthquake resistance of each consumer good is calculated by dividing the amount of earthquake-resistant consumer goods in a house by their quantity. The rate of unnecessary consumer goods is also calculated by dividing the quantity of unnecessary consumer goods by the quantity of consumer goods. By multiplying this ratio with Eq. (1), the unnecessary micro-material stock was calculated.

2.3. Potential disaster waste derived from consumer goods

The natural disaster assumed in this study is an earthquake and its consequences, such as liquefaction and tsunami. The potential disaster waste derived from consumer goods is estimated based on the procedure by Wakabayashi et al. [4] and Tabata et al. [17]. Figure 3 shows a flow diagram of the estimation of potential disaster waste considering earthquakes, liquefactions, and tsunamis. The grid data for the number of household units (area of one grid is 0.25 km^2) based on the national population census is utilized for the estimation [40]. This census provides the number of housing units based on age groups and the number of elderly housing units. The micro-material stock derived from consumer goods that the household-only units possess is calculated by multiplying the parameters obtained from Eqns. (1) and (2): Similarly, the micro-material stock derived from consumer goods that regular household units possess is also calculated. The disaster waste derived from consumer goods is estimated by overlaying the grid data of the micro-material stock and hazard maps representing damages such as earthquakes, liquefication, and tsunamis.

By calculating the number of dwellings by percent destruction in each grid, the number of completely and partially destroyed buildings in each grid was calculated. The number of completely and partially destroyed buildings was determined by damage functions. Figure 3 shows examples of the damage functions (here, the fragility function of dwellings (wooden construction) caused by an earthquake). The fragility function of dwellings (non-wooden construction) is also provided [41]. In case of complete destruction, all micro-material stock in the housing is assumed to be converted into disaster waste. In the case of partial destruction, the degree of conversion depends on the type of damage. For example, in the event of an earthquake, all consumer goods without earthquake resistance are assumed to become disaster waste. In the event of liquefaction, all consumer goods are assumed to be converted to disaster waste even if they are only partially destroyed because of the risk that the housing unit might tilt and consumer goods fall. In the case of a tsunami, all consumer goods installed on the first floor of the dwelling are assumed to become disaster waste, and consumer goods installed on the second floor and above may remain intact. In such a case, the disaster waste is calculated by multiplying the percentage of consumer goods installed on the first floor and second floor and above using the results of [18].

Assuming that the aforementioned damages do not occur simultaneously is important for estimating potential disaster waste. Liquefaction and tsunamis usually occur after earthquakes. Consequently, double-counting might occur when estimating potential disaster waste derived from micro-material stock on a specific grid due to three types of damages. Therefore, the potential disaster waste for each type of damage in this study was separately estimated based on Wakabayashi et al. [4].

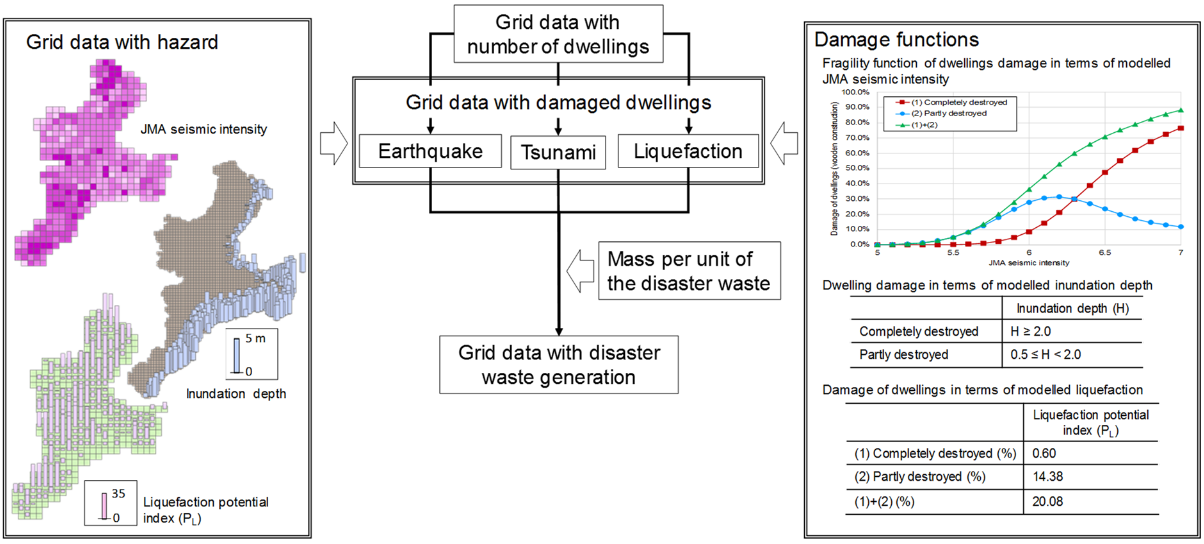

Figure 3 Procedure for estimating potential disaster waste (Wakabayashi et al. [3])

2.4. Case study

In this section, case studies in two Japanese cities (Minami-Ise in the Mie Prefecture and Kobe in the Hyogo Prefecture) were conducted to estimate the potential disaster waste derived from consumer goods, with a focus on Nankai megathrust earthquakes. The earthquakes have epicenters in the Nankai Trough located southwest of Japan (Figure A.1). The Japanese national government predicts that the probability of an M8–M9 class earthquake occurring in the next 30 years from January 2020 is approximately 70–80% [42]. If the earthquakes struck, more damage might occur than in the 2011 Great East Japan Earthquake. JMOE [10] indicates that the earthquake will cause an estimated maximum number of 323,000 deaths, and the quantity of disaster waste is estimated to be 250 million tons.

The locations of Minami-Ise and Kobe are shown in Figure A.1 in the Appendices. These two cities are selected for comparison of the results because they have significantly varied city sizes and aging rates. Minami-Ise is located along the coast of western Japan and is expected to be strongly affected by earthquakes and tsunamis. The total area of the city is approximately 242 km^2; most of the city consists of mountainous areas. Residential areas constitute approximately 1% of the total area [40]. The coastline of the city, where the majority of residents live, is approximately 245.6 km long. The population of the city was approximately 12,800 in 2015, and the aging rate[1] was 49.1% [43]. This rate is much higher than the national average of 26.6% recorded in 2015 [33]. There are 5,442 household units in the city, and approximately 45.4% are elderly households [43]. In contrast, Kobe is a large city with a population of approximately 1.54 million in 2015 [43]. Although less affected by tsunamis than Minami-Ise, strong ground motion is predicted in this city [27]. The total area of the city is approximately 557 km^2, which is 2.3 times larger than Minami-Ise, and the population is approximately 120 times that of Minami-Ise [44]. The aging rate is 26.8%, which is close to the national average. There are approximately 706,000 household units in this city, approximately 26.0% of which are elderly [43].

In the case studies, the potential disaster waste derived from consumer goods is estimated based on the micro-material stock derived from consumer goods that are in household-only units and regular household units. The degree of disaster waste prevention is estimated if unnecessary consumer goods are reduced and/or the earthquake resistance of consumer goods is used. Minami-Ise is expected to be strongly affected by earthquakes, liquefaction, and tsunamis; therefore, the potential disaster waste was estimated considering three types of damage: earthquakes, liquefaction, and tsunamis. Because Kobe is not affected significantly by liquefaction and tsunamis, the potential disaster waste was estimated considering only earthquakes. The target dwellings are only detached houses. In Minami-Ise, the rate of housing complexes to the total number of housing units is approximately 6%; therefore, housing complexes were supposed to be ignored [43]. In Kobe, detached houses account for approximately 36% of total housing, and approximately 62% of housing complexes are more common [43]. However, this city considered that earthquake damage may not occur at the scale of Minami-Ise. The housing complexes that are considered relatively resistant to earthquakes were supposedly excluded in case studies.

3. Results and discussions

3.1. Demographic properties

Table A.1 in the Appendices shows the results of the demographic properties of the

[1] The percentage of the population aged 65 or over of the total population

respondent. Respondents are most likely in the age range of 65–69 years. The average number of people living in the household units is 1.84, and the average annual income is 4.64 million JPY (0.042 million USD[2]). Based on this data, many respondents have presumably retired and live on pension income. Many respondents have lived in detached housing, most often built between 1980 and 1989, for more than 31 years. Based on this data they presumably constructed their own houses during life events such as marriage and birth, as described in Kalleberg [39]. Table 2 shows the comparison of demographic properties between elderly-only household units and regular household units [18]. Although the two surveys differed in timing and location, the questions in the survey were almost the same. Because the survey results in Tabata et al. [18] targeted all household units, the average age of respondents is lower, and the number of residents is greater than the survey results of the current study. In contrast, the total floor area of the elderly-only household units is greater than that of regular household units, because the elderly are more likely than the younger population to live in detached housing.

Table 2 Comparison of demographic properties

	Elderly-only household units (This study)	Regular household units (Tabata et al. 2018)
Number of respondents	220	415
Age of respondent (Average)	69.84	36.59
Number of household (average)	1.84	2.62
Annual income (Average) [million JPY]	4.64	7.97
[million USD]	0.042	0.073
Total floor area (Average) [m^2]	93.72	67.38

Table A.2 in the Appendices shows the average possession of consumer goods in a housing

[2] The exchange rate applied was 0.0091 USD = 1 JPY (as of June 6, 2020).

unit, by the total floor area and the type of dwelling. Because the number of respondents was extremely small when the total floor area of a detached housing was less than 69 m^2, the results from total floor area less than 29 m^2 and up to 69 m^2 were aggregated as less than 69 m^2. The total number of consumer goods possessed in a housing unit was 18.72 units (21.5 units for detached housing and 15.8 units for housing complexes). More consumer goods are installed in detached housing units than in housing complexes, because the average total floor area in this survey was 94 m^2 for detached housing and 69 m^2 for housing complexes. The percentage in parentheses indicates the ratio of unnecessary consumer goods (Table A.2). The average quantity of unnecessary consumer goods was 20.9% (21.3% for detached housing and 18.6% for housing complexes). This result revealed that roughly 20% of consumer goods are unnecessary. Thus, sales of CRT TV sets were discontinued due to the start of national digital broadcasting in 2010. According to the technical change, replacement with flat TV sets was promoted and CRT TV sets were discarded. However, this survey result indicates that a small number of household units retain CRT TV sets in 2019.

Table 3 shows the results of the correlation matrix between the demographic properties of the respondents. To convert the results of qualitative variables into numbers, the numbers listed next to the answers in Table A.1 were used. The bold and italic numbers in the table indicate significant results at the 1% or 5% level. The average possession of consumer goods in a housing unit ((g) in Table 3) has a positive correlation with the number of household units, including respondents (b), total floor area (e), and residence years (f). Conversely, the type of dwelling (d) has a negative correlation with (g). The average possession of necessary consumer goods in a housing unit (h) tended to be the same as that of (g). However, the average possession of unnecessary consumer goods in a housing unit (i) is significant only for (g). The number of household units and the total floor area are not affected by (i).

Table 3 Correlation matrix

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)

(a)	-	0.02	-0.02	0.05	-0.13	0.07	0.04	-0.06	0.12
(b)		-	***0.31***	***-0.16***	***0.14***	***0.18***	***0.22***	***0.24***	0.08
(c)		**	-	***-0.14***	***0.33***	-0.04	0.02	0.10	-0.09
(d)		*	*	-	***-0.45***	***-0.38***	***-0.14***	***-0.22***	0.03
(e)		*	**	**	-	0.11	***0.14***	***0.22***	-0.03
(f)		**		**		-	***0.18***	***0.20***	0.05
(g)		**		*	*	**	-	***0.75***	***0.70***
(h)		**		**	**	**	**	-	0.05
(i)							**		-

Note: *: $p<0.05$ and **: $p<0.01$.

(a) Age group, (b) Number of household units including respondents, (c) average annual income, (d) type of dwelling, (e) total floor area, (f) residence years, (g) average possession of consumer goods in a housing unit, (h) Average possession of necessary consumer goods in a housing unit, and (i) average possession of unnecessary consumer goods in a housing unit.

Table A.3 in Appendices shows rate of earthquake resistance by type of consumer goods. The average rate of earthquake resistance of all consumer goods was 35.4%. CRT TV sets, bookshelf (height 1 m to less than 1.5 m), and miscellaneous furniture (height >1.5 m) had the highest rate of 100%. Furniture (height <1 m) was 64.0%; however, the higher furniture remained at a lower rate. Another result revealed that there rare rate of fall of consumer goods, such as refrigerators, could nevertheless affect human life. The percentage of all unnecessary consumer goods was 17.8%, with a higher proportion for furniture. Figure 4 shows the reasons for discarding unnecessary consumer goods. The most common response (of 35.2%) was “Nothing/I didn't discard it”, and 18.1% of respondents kept the item for visits and family homecoming. Although some respondents have consumer goods that should be discarded, some respondents answered that they would like to discard and item too large or difficult to dispose of.

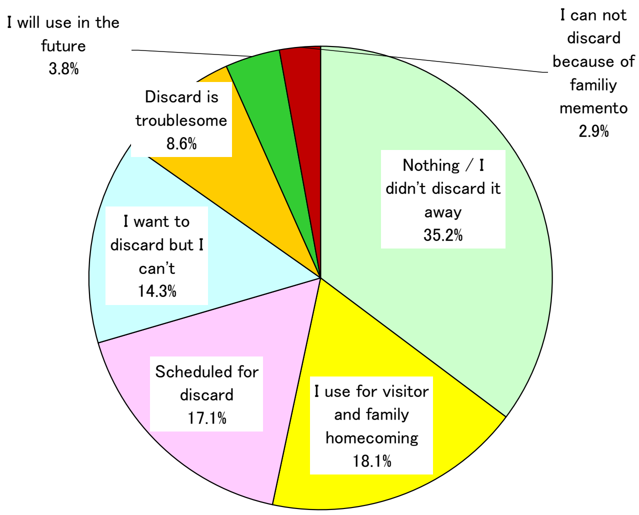

Figure 4 Why do respondents discard unnecessary consumer goods?

3.2. Micro-material stock in a housing unit

Table A.4 in Appendices shows average micro-material stock derived from consumer goods in a housing unit by total floor area and by type of dwelling. Table 4 shows average micro-material stock derived from consumer goods in a housing unit as a whole. Total is the result of combining detached housing and housing complexes. Therefore, in regular household units was 839 kg. In contrast, the total micro-material stock in each elderly household unit was 1,216 kg—approximately 1.4 times higher than in regular household units. From the results of detached housing, micro-material stock tended to increase according to the total floor area. These are similar results from regular household units (Table 4). The micro-material stock in elderly-only household units was 23–40% higher than in regular household units. Thus, elderly-only household units have a larger micro-material stock than regular household units. However, there was no micro-material stock tendency in housing complexes or in regular household units. Housing complexes might have heavy micro-material stock, although the total number of consumer goods possessed is lower than in detached housing. Additional surveys are necessary to document the difference between detached housing units and housing complexes. Additionally, Table 4 reveals that the percentage of necessary consumer goods in elderly-only household units was lower than that of regular household units, because multiple consumer goods remain in the household units after the children become independent. Thus, elderly-only household units have more micro-material stock than regular household units.

Table 4 Average micro-material stock derived from consumer goods in a housing unit

Elderly household units (This study)			
Total floor area	(1) Total	(2) Detached housing	(3) Housing complexes
<69 m^2	1,018 (79%)	850 (75%)	1,103 (80%)
70–99 m^2	1,432 (88%)	1,258 (89%)	1,634 (88%)
≥100 m^2	1,594 (89%)	1,554 (79%)	1,525 (98%)
Average	1,216 (84%)	1,072 (80%)	1,294 (86%)
Regular household units (Tabata et al. [18])			
Total floor area	(1) Total	(2) Detached housing	(3) Housing complexes
<69 m^2	587 (96%)	606 (95%)	441 (97%)
70–99 m^2	1,086 (95%)	965 (94%)	1,196 (95%)
≥100 m^2	1,347 (93%)	1,349 (96%)	1,362 (91%)
Average	839 (95%)	826 (95%)	776 (95%)

Unit: kg/housing

Note: The percentage in parentheses indicates the rate of necessary consumer goods.

3.3. Case study

3.3.1. Case of Minami-Ise

Figure 5 shows the spatial distribution of micro-material stock derived from consumer goods using GIS; the area of one grid is 0.25 km^2. Therefore, the micro-material stock derived from consumer goods was estimated at 15,000 t, of which 49.1% was derived from elderly-only household units. Thus, micro-material stock in elderly-only household units can not be ignored in this city.

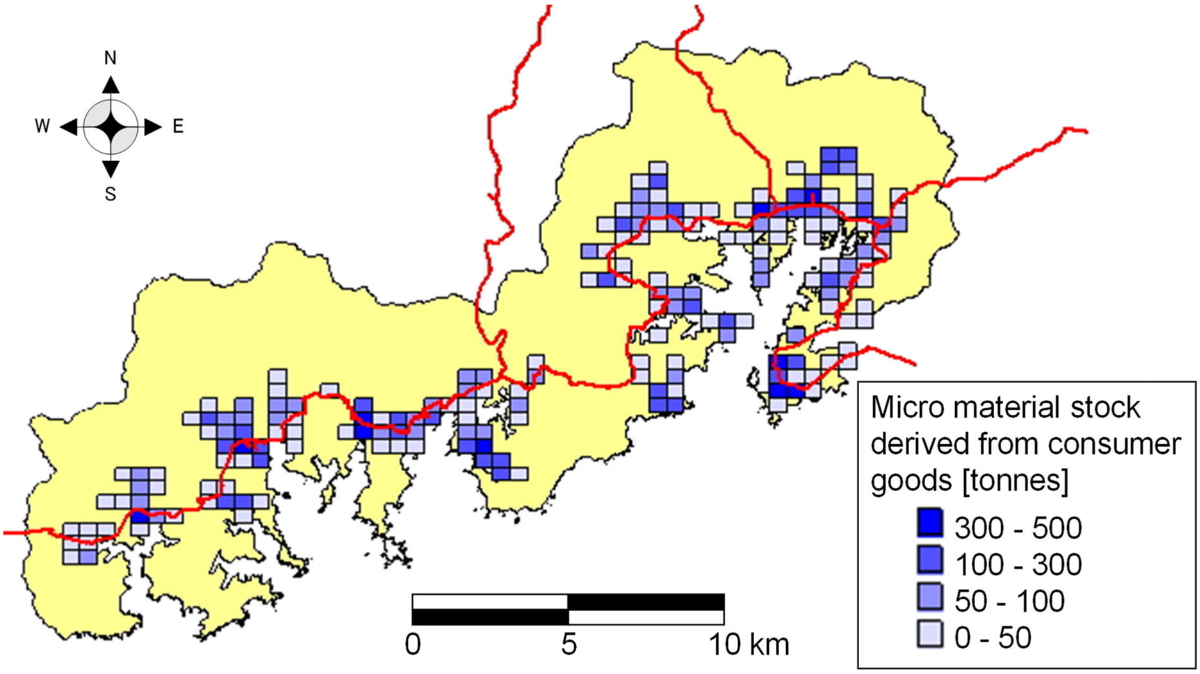

Figure 5 Spatial distribution of micro-material stock derived from consumer goods

Note: Red line indicates main road.

Figure 6 shows the spatial distribution of potential disaster waste derived from consumer goods. If Nankai-type megathrust earthquakes were to occur, 39.9% and 54.9% of detached housing might be completely/partially destroyed, respectively. Subsequently, 12,400 t of the potential disaster waste derived from consumer goods may be generated. This equates to 83% of the micro-material stock derived from consumer goods in the city, and 54% of the total disaster waste could be generated from elderly-only household units. If the rate of earthquake resistance of consumer goods was 100% based on the rate in questionnaire survey (35.4%), results revealed that 22.5% of the potential disaster waste might be reduced. The earthquake resistance of consumer goods helps reduce disaster waste generation but is limited to the cases of partial destruction of dwellings. Additionally, if unnecessary consumer goods were removed before the disaster, results reveal that 35% of potential disaster waste might be reduced.

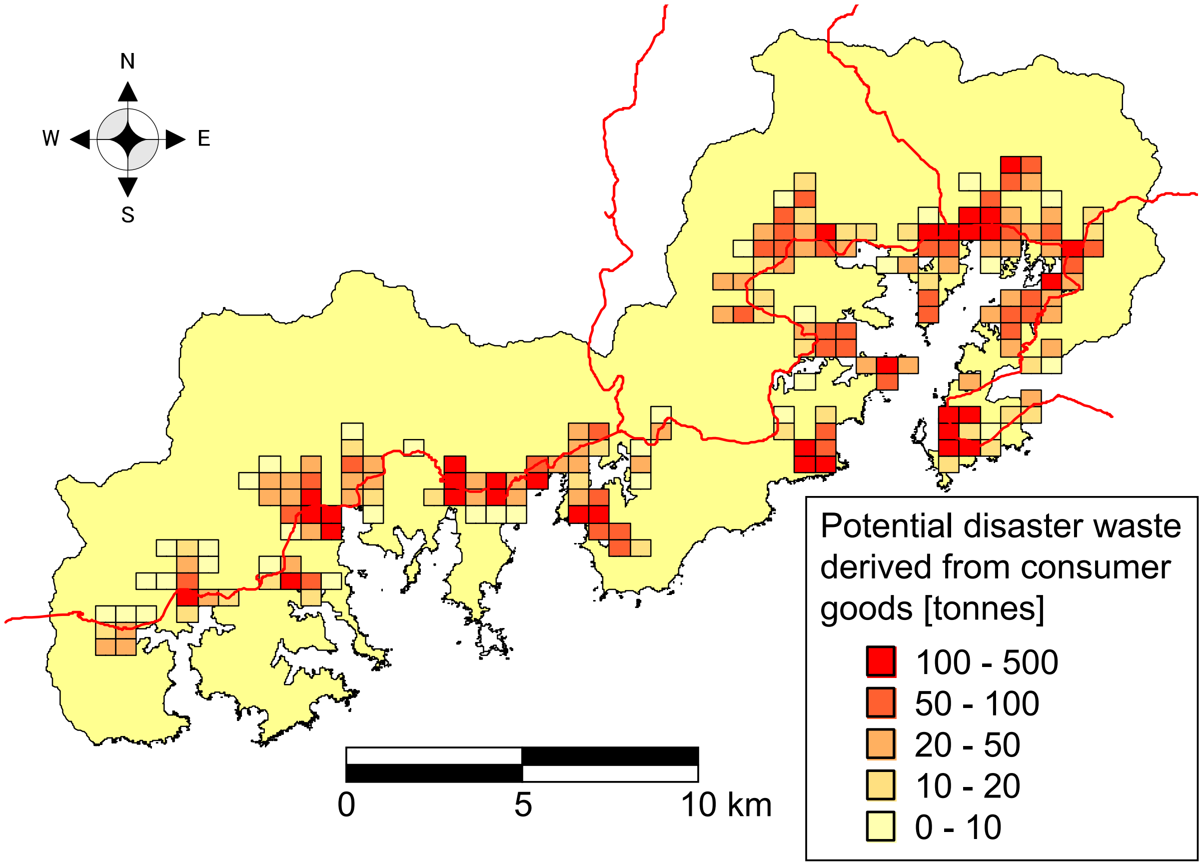

Figure 6 Spatial distribution of potential disaster waste derived from consumer goods

Note: Red line indicates main road.

The estimated micro-material stock and potential disaster waste are divided into elderly and regular household units. When the basic unit of regular household units was applied to the elderly-only household units, the micro-material stock decreased to 13,400 t, and the estimation result was underestimated. Potential disaster waste would also be underestimated by 9,800 tons. When the potential disaster waste is estimated, the universal basic unit does not consider the type of household unit. However, this study revealed that the basic unit for estimating potential disaster waste might be different between elderly-only and regular household units. In areas such as Minami-Ise with very high aging rates and many household-only units, a discussion on how to use the basic unit properly is necessary. This study revealed that earthquake-resistant consumer goods are effective for disaster waste prevention. Additionally, removing unnecessary consumer goods effectively prevents disaster waste. Storing unnecessary consumer goods at home might damage residents when it falls in the event of an earthquake. The results of this study suggest that measures such as the earthquake resistance of consumer goods and the removal of unnecessary consumer goods are important for protecting human lives and property and for preventing disaster waste.

3.3.2. Case of Kobe

Figure 7 shows the spatial distribution of potential disaster waste derived from consumer goods. The micro-material stock derived from consumer goods was approximately 626,000 t, of which 34.9% were derived from household-only units. If the earthquakes occurred, 0.4% of detached dwellings in the city might be completely destroyed, and 3.1% might be partially destroyed. The potential disaster waste derived from consumer goods is estimated at 430,000 t and is equivalent to 68.7% of the micro-material stock derived from consumer goods. Kobe is less affected by earthquakes than Minami-Ise and unlikely to be affected by tsunamis. Therefore, it is important to implement measures for disaster waste prevention due to earthquakes in this city. If the rate of earthquake resistance of consumer goods increased to 100% from the current level, potential disaster waste might be drastically reduced to 6,900 tons, and 17.8% of potential disaster waste might be reduced by removing unnecessary consumer goods before a disaster event.

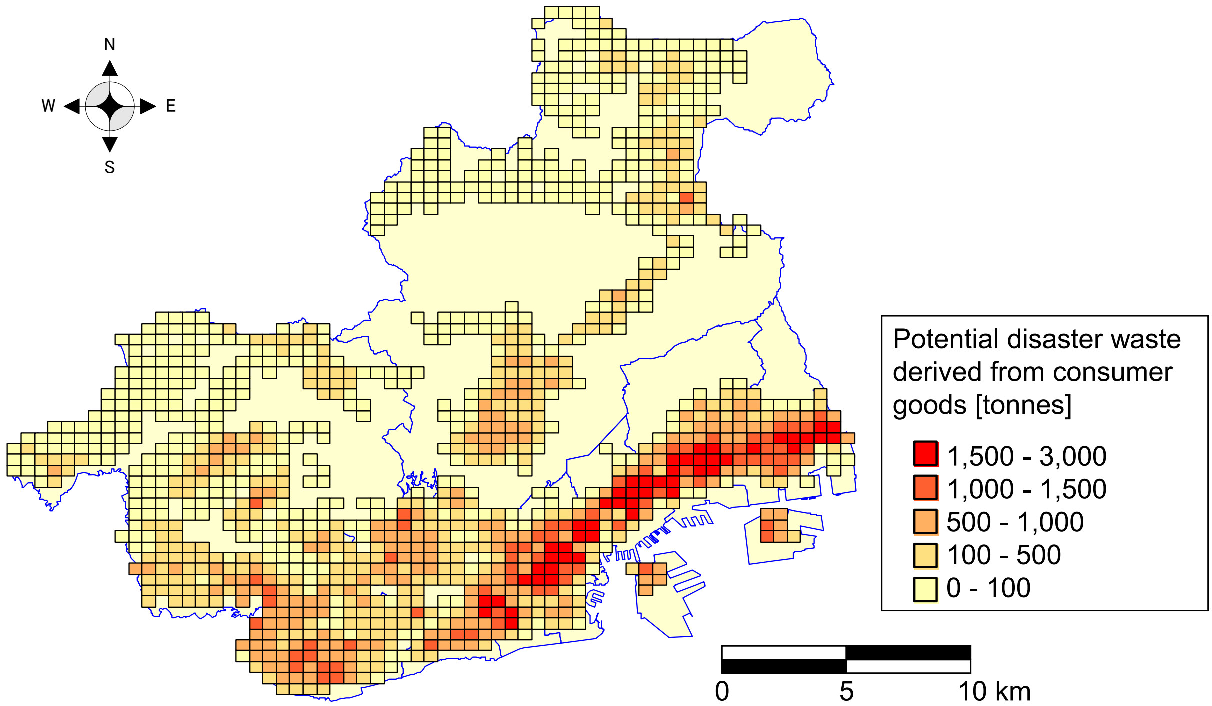

Figure 7 Spatial distribution of potential disaster waste derived from consumer goods

Figure 8 shows the rate of potential disaster waste derived from consumer goods generated by household-only units. The Kobe aging rate is close to the national average and lower than that of Minami-Ise. However, the aging rate is higher depending on the location within Kobe. Potential disaster waste derived from household-only units was particularly prominent in the south-western region. Thus, the local government should implement effective measures, such as subsidies for the earthquake resistance of consumer goods, in areas with many elderly households to prevent disaster waste.

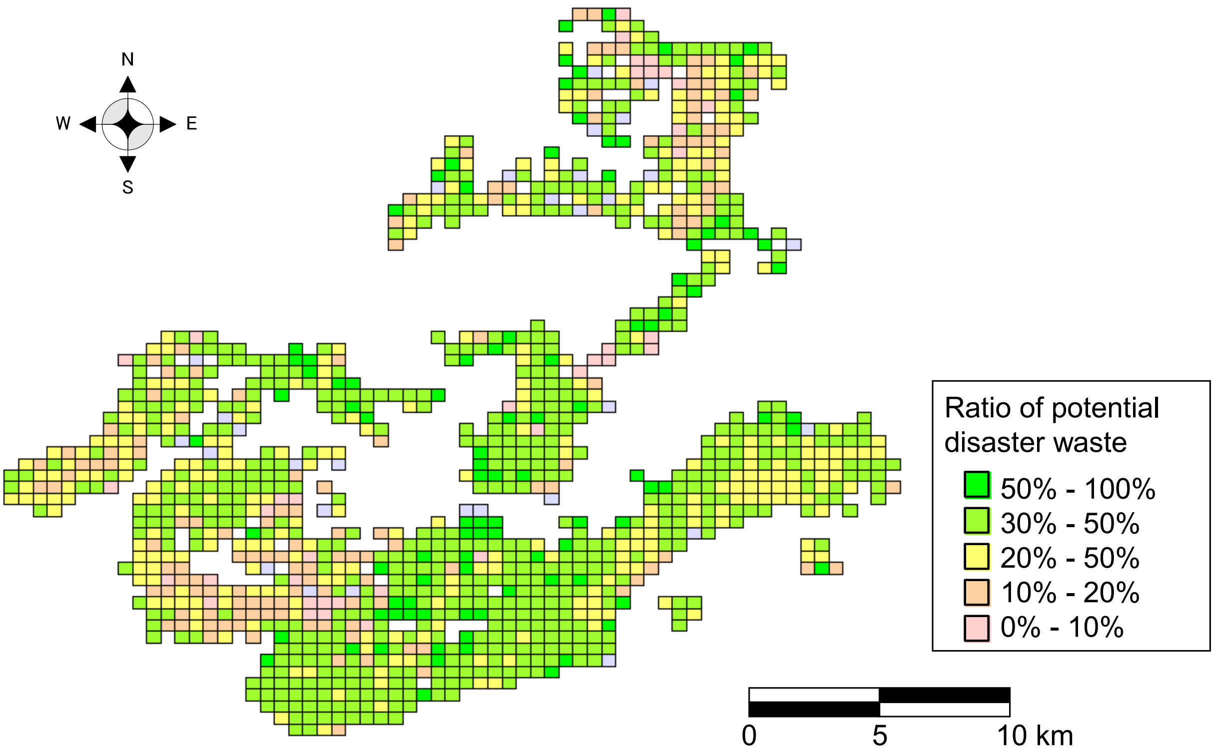

Figure 8 Rate of potential disaster waste derived from consumer goods generated by elderly-only household units

4. Summary and outlook

This study clarified the actual situation of consumer goods possessed in elderly-only households and their earthquake resistance consumer goods. Micro-material stock derived from consumer goods was estimated, and the result was compared with that of regular households. Case studies in two earthquake-prone cities were conducted; these cities were also prone to liquefication and tsunami. Then, the potential disaster waste derived from consumer goods was estimated based on the estimated micro-material stock. The primary findings of the current study are as follows:

(1) A web questionnaire survey was conducted on elderly households in the Kansai region of Japan. This survey was intended to investigate the quantity and type of consumer goods (22 types) the household possessed as well as the quantity and type of earthquake-resistant consumer goods. The total number of consumer goods possessed in a housing unit was 18.72

units (21.5 units for detached housing and 15.8 units for housing complexes). The average quantity of unnecessary consumer goods was 20.9% (21.3% for detached housing and 18.6% for housing complexes). The average rate of earthquake resistance for all consumer goods was 35.4%. Although CRT TV sets, bookshelves (height 1–1.5 m), and miscellaneous furniture (height ≥1.5 m) had the highest rates of earthquake resistance, almost all other consumer goods including furniture had low rates.

(2) This survey also aimed at determining why respondents do not discard unnecessary consumer goods. The most common response (of 35.2%) was “Nothing/I didn't discard it”, and 18.1% of the respondents answered that they kept the item for use during social visits and family homecomings. Some respondents said that they did not discard these good because they were too large or difficult to discard.

(3) The average micro-material stock in a housing unit (1,216 kg per household) is approximately 1.4 times higher than that of regular household units, as reported in a previous study, indicating that elderly households have a larger micro-material stock than regular households.

(4) From the first case study in Minami-Ise, which has an extremely high aging rate and several elderly-only household units, the micro-material stock derived from consumer goods was estimated to be 15,000 t, and 49.1% of the micro-material stock was derived from elderly-only households. The potential disaster waste derived from consumer goods was an estimated 12,400 t if Nankai megathrust earthquakes were to occur. In that case, 54.0% of the disaster waste might be generated from only household units. If the rate of earthquake resistance of consumer goods was 100%, the result revealed that 22.5% of the potential disaster waste might be reduced. Furthermore, if unnecessary consumer goods were removed before the disaster, 35.0% of the potential disaster waste might be reduced.

(5) From the second case study in Kobe, the micro-material stock derived from consumer goods was approximately 626,000 t, of which 34.9% was derived from elderly-only households. The potential disaster waste derived from consumer goods was an estimated 430,000 t if Nankai megathrust earthquakes were to occur. Although the aging rate in Kobe is close to the national average, there are areas where the aging rate is higher. Areas where potential disaster waste

derived from household-only units was particularly prominent were visualized using GISs. Therefore, implementation of effective disaster waste prevention measures by the local government, such as subsidies for the earthquake resistance of consumer goods in areas with several elderly-only households are needed.

Japan has an increasing aging rate and number of elderly-only household units. This issue is not a problem unique to Japan, as the aging rate in other countries is also increasing. The micro-material stock in a housing unit is not the same for all household units and varies according to the type of dwelling and the total floor area. One of the findings of this study is that the micro-material stock derived from consumer goods of household-only units is larger than that of regular household units. Estimation of the micro-material stock in a region using a universal basic unit might lead to an underestimation. Thus, using an appropriate basic unit considering the regional aging rate is crucial for a highly realistic estimation. We also found a percentage of unnecessary consumer goods that include consumer goods that cannot be discarded for certain reasons.

Local governments are responsible for the removal and treatment of disaster waste. They must plan and manage disaster waste treatment strategies for future disasters in advance. Management should be implemented with the highest priority given to controlling disaster waste generation. Additionally, local governments should advocate a lifestyle suitable to disaster waste prevention to local residents before the occurrence of disasters. Local governments can estimate and understand the future outlook of MSW generation in advance. A key point in disaster waste management is the preliminary estimation of potential disaster waste generation [17]. If the basic unit of the micro-material stock considering the aging rate of the region is used, potential disaster waste can be estimated by considering the actual situation. Local governments are required to implement educational activities and economic measures for disaster waste prevention, such as increasing the rate of the earthquake resistance of consumer goods and removing unused consumer goods in advance. It is expected that implementing these measures may protect the lives and property of elderly individuals and reduce potential disaster waste.

Acknowledgments

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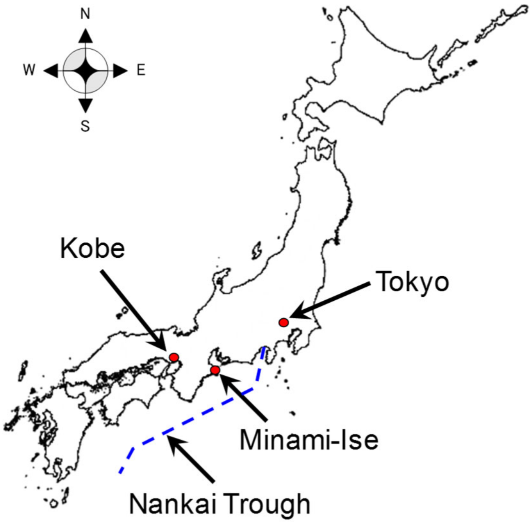
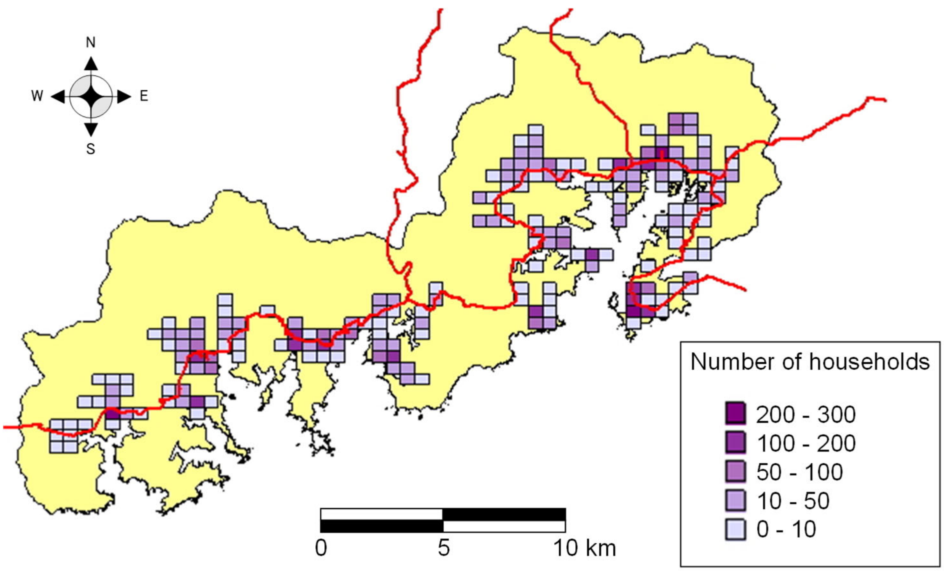
Appendices

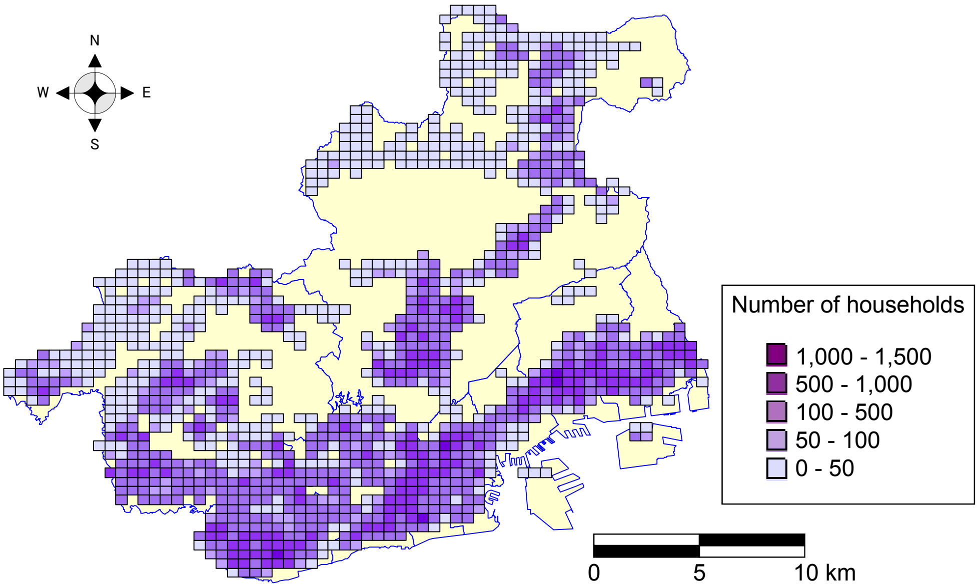


(a) Location



(b) Spatial distribution of the number of household units (Minami-Ise)

Note: Red line indicates main road.



(c) Spatial distribution of the number of households (Kobe)

Figure A.1 Case study area

Table A.1 Results of demographic properties

Sex of respondents	1: Male	113	Total floor area	1: Below 29 m^2	6
	2: Female	107		2: 30 m^2 to 49 m^2	13
Age group of respondents	1: 65 years to 69 years	117		3: 50 m^2 to 69 m^2	35
	2: 70 years to 74 years	75		4: 70 m^2 to 99 m^2	71
	3: 75 years to 79 years	23		5: 100 m^2 to 149 m^2	50
	4: 80 years or above	5		6: 150 m^2 or above	25
Number of household including respondents	1: 1 person	49		Unknown	20
	2: 2 persons	159	Construction period	1: Before 1959	17
	3: 3 persons	10		2: 1960 to 1969	10
	4: 4 persons	2		3: 1970 to 1979	30
Annual income of household*	1: Below 3 million JPY	65		4: 1980 to 1989	52
	2: 3 million JPY to 4.99 million JPY	73		5: 1990 to 1999	41
	3: 5 million JPY to 6.99 million JPY	25		6: 2000 to 2009	31
	4: 7 million JPY to 9.99 million JPY	9		7: Since 2010	18
	5: 10 million JPY to 14.99 million JPY	4		Unknown	21
	6: 15 million JPY to 19.99 million JPY	3	Residence years	1: Less than one year	2
	7: 20 million JPY or above	1		2: 1 to 5 years	23
	Unknown/ I do not want to answer	40		3: 6 to 10 years	31
Type of dwellings	1: Detached housing	127		4: 11 to 20 years	42
	2: Complex housing	90		5: 21 to 30 years	44

	Miscellaneous	3		6: More than 31 years	78

Note: Number before colon indicates regular scale.

Table A.2 Average possession of consumer goods in a housing unit

(a) Total

Floor area	Below 69 m^2	70 to 99 m^2	100 m^2 or above	Average
Number of respondent	52	71	75	198
Gas stoves and/or IH cooking heaters	1.82 (29%)	1.73 (22%)	2.63 (51%)	2.06 (37%)
Refrigerators	1.53 (27%)	1.56 (21%)	0.57 (0%)	1.22 (0%)
Dishwashers	0.29 (69%)	0.54 (37%)	1.69 (83%)	0.84 (71%)
Microwave ovens	1.53 (28%)	1.45 (19%)	0.4 (0%)	1.13 (0%)
CRT TV sets	0.09 (89%)	0.15 (73%)	1.39 (96%)	0.54 (94%)
Flat TV sets	2.49 (28%)	2.45 (14%)	0.29 (0%)	1.75 (0%)
Dressers (Height less than 1 m)	0.8 (36%)	0.51 (17%)	3 (76%)	1.44 (62%)
Dressers (Height 1 m to less than 1.5 m)	0.91 (27%)	1.11 (18%)	0.85 (0%)	0.96 (12%)
Dressers (Height 1.5 m or above)	0.96 (8%)	1.75 (8%)	1.12 (0%)	1.27 (0%)
Cupboard (Height less than 1 m)	0.58 (43%)	0.3 (14%)	1.91 (73%)	0.93 (61%)
Cupboard (Height 1 m to less than 1.5 m)	0.26 (30%)	0.44 (19%)	0.55 (37%)	0.41 (29%)
Cupboard (Height 1.5 m or above)	0.68 (11%)	1.21 (12%)	0.4 (0%)	0.76 (0%)
Bookshelf (Height less than 1 m)	0.62 (23%)	0.3 (19%)	1.2 (70%)	0.71 (49%)
Bookshelf (Height 1 m to less than 1.5 m)	0.3 (32%)	0.38 (30%)	0.48 (0%)	0.39 (17%)
Bookshelf (Height 1.5 m or above)	0.45 (24%)	1.28 (7%)	0.55 (0%)	0.76 (0%)
Miscellaneous Furniture (Height less than 1 m)	0.62 (14%)	0.97 (10%)	1 (0%)	0.86 (7%)
Miscellaneous Furniture (Height 1 m to less than 1.5 m)	0.37 (21%)	0.39 (14%)	1.05 (35%)	0.61 (28%)
Miscellaneous Furniture (Height 1.5 m or above)	0.3 (25%)	0.35 (12%)	0.73 (35%)	0.46 (27%)
Beds	0.86 (22%)	0.94 (12%)	0.55 (0%)	0.78 (0%)
Table sets	0.85 (20%)	1.13 (11%)	1.79 (40%)	1.25 (27%)
Reception sets	0.63 (25%)	0.82 (12%)	1.19 (36%)	0.88 (26%)
Study desks and learning desks	0.57 (19%)	1.15 (9%)	0.83 (0%)	0.85 (0%)

(b) Detached housing

Floor area	Below 69 m^2	70 to 99 m^2	100 m^2 or above	Average
Number of respondent	12	31	71	114
Gas stoves and/or IH cooking heaters	1.89 (34%)	1.58 (12%)	2.68 (52%)	2.05 (36%)
Refrigerators	2.44 (37%)	1.68 (17%)	0.54 (0%)	1.55 (6%)
Dishwashers	0.87 (57%)	0.32 (20%)	1.73 (85%)	0.98 (69%)
Microwave ovens	1.81 (30%)	1.42 (14%)	0.34 (0%)	1.19 (0%)
CRT TV sets	0 (100%)	0.1 (33%)	1.46 (96%)	0.52 (92%)
Flat TV sets	4.07 (35%)	2.65 (12%)	0.11 (0%)	2.28 (0%)
Dressers (Height less than 1 m)	1.56 (54%)	0.61 (5%)	3.17 (76%)	1.78 (62%)
Dressers (Height 1 m to less than 1.5 m)	1.57 (24%)	1.35 (19%)	0.85 (0%)	1.26 (14%)
Dressers (Height 1.5 m or above)	0.96 (4%)	1.71 (9%)	1.1 (0%)	1.26 (0%)
Cupboard (Height less than 1 m)	0.19 (40%)	0.29 (0%)	1.97 (75%)	0.82 (63%)
Cupboard (Height 1 m to less than 1.5 m)	0.04 (0%)	0.55 (12%)	0.55 (38%)	0.38 (24%)
Cupboard (Height 1.5 m or above)	0.7 (0%)	1 (13%)	0.38 (0%)	0.69 (0%)
Bookshelf (Height less than 1 m)	0.48 (69%)	0.23 (0%)	1.25 (71%)	0.65 (62%)
Bookshelf (Height 1 m to less than 1.5 m)	0.11 (0%)	0.45 (14%)	0.44 (0%)	0.33 (5%)
Bookshelf (Height 1.5 m or above)	0.15 (0%)	1.23 (5%)	0.56 (0%)	0.65 (0%)
Miscellaneous Furniture (Height less than 1 m)	0.07 (0%)	1.26 (5%)	0.97 (0%)	0.77 (2%)
Miscellaneous Furniture (Height 1 m to less than 1.5 m)	0.41 (0%)	0.45 (0%)	1.07 (37%)	0.64 (20%)
Miscellaneous Furniture (Height 1.5 m or above)	0.07 (0%)	0.35 (9%)	0.75 (36%)	0.39 (26%)
Beds	1.09 (31%)	0.71 (5%)	0.54 (0%)	0.78 (0%)
Table sets	0.91 (4%)	1.16 (11%)	1.83 (42%)	1.3 (24%)
Reception sets	0.26 (29%)	0.65 (10%)	1.2 (38%)	0.7 (28%)
Study desks and learning desks	0.67 (56%)	1.06 (6%)	0.86 (0%)	0.86 (6%)

(c) Complex housing

Floor area	Below 69 m^2	70 to 99 m^2	100 m^2 or above	Average
Number of respondent	40	40	4	84
Gas stoves and/or IH cooking heaters	1.77 (29%)	1.85 (28%)	1.75 (29%)	1.79 (29%)
Refrigerators	1.38 (26%)	1.48 (24%)	1.25 (20%)	1.37 (23%)
Dishwashers	0.19 (65%)	0.7 (43%)	1 (25%)	0.63 (36%)
Microwave ovens	1.42 (29%)	1.48 (24%)	1.5 (33%)	1.47 (29%)
CRT TV sets	0.1 (86%)	0.2 (87%)	0 (100%)	0.1 (87%)
Flat TV sets	2.27 (29%)	2.3 (16%)	3.5 (29%)	2.69 (25%)
Dressers (Height less than 1 m)	0.39 (18%)	0.43 (29%)	0 (100%)	0.27 (24%)
Dressers (Height 1 m to less than 1.5 m)	0.6 (20%)	0.93 (16%)	1 (0%)	0.84 (11%)
Dressers (Height 1.5 m or above)	0.91 (9%)	1.78 (7%)	1.5 (0%)	1.4 (5%)
Cupboard (Height less than 1 m)	0.77 (43%)	0.3 (25%)	0.75 (0%)	0.61 (22%)
Cupboard (Height 1 m to less than 1.5 m)	0.29 (29%)	0.35 (29%)	0.5 (0%)	0.38 (16%)
Cupboard (Height 1.5 m or above)	0.69 (12%)	1.38 (11%)	0.75 (0%)	0.94 (8%)
Bookshelf (Height less than 1 m)	0.66 (21%)	0.35 (29%)	0.25 (0%)	0.42 (19%)
Bookshelf (Height 1 m to less than 1.5 m)	0.36 (31%)	0.33 (46%)	1.25 (0%)	0.64 (13%)
Bookshelf (Height 1.5 m or above)	0.57 (22%)	1.33 (8%)	0.25 (0%)	0.72 (10%)
Miscellaneous Furniture (Height less than 1 m)	0.74 (13%)	0.75 (17%)	1.5 (0%)	1 (7%)
Miscellaneous Furniture (Height 1 m to less than 1.5 m)	0.38 (22%)	0.35 (29%)	0.75 (0%)	0.49 (12%)
Miscellaneous Furniture (Height 1.5 m or above)	0.33 (25%)	0.35 (14%)	0.5 (0%)	0.39 (11%)
Beds	0.93 (24%)	1.13 (16%)	0.75 (0%)	0.94 (14%)
Table sets	0.84 (26%)	1.1 (11%)	1 (0%)	0.98 (12%)
Reception sets	0.77 (25%)	0.95 (13%)	1 (0%)	0.91 (12%)
Study desks and learning desks	0.56 (15%)	1.23 (10%)	0.25 (0%)	0.68 (10%)

Unit: items/housing

Note: The percentage in parentheses indicates the ratio of unnecessary consumer goods

Table A.3 Rate of earthquake-resistance of each consumer goods

Gas stoves and/or IH cooking heaters	16.6%
Refrigerators	4.2%
Dishwashers	42.3%
Microwave ovens	2.4%
CRT TV sets	100.0%
Flat TV sets	17.9%
Dressers (Height less than 1 m)	64.0%
Dressers (Height 1 m to less than 1.5 m)	32.3%
Dressers (Height 1.5 m or above)	31.9%
Cupboard (Height less than 1 m)	19.0%
Cupboard (Height 1 m to less than 1.5 m)	59.3%
Cupboard (Height 1.5 m or above)	27.6%
Bookshelf (Height less than 1 m)	30.6%
Bookshelf (Height 1 m to less than 1.5 m)	100.0%
Bookshelf (Height 1.5 m or above)	77.9%
Miscellaneous Furniture (Height less than 1 m)	6.5%
Miscellaneous Furniture (Height 1 m to less than 1.5 m)	35.5%
Miscellaneous Furniture (Height 1.5 m or above)	100.0%
Beds	1.9%
Table sets	5.9%
Reception sets	2.1%
Study desks and learning desks	1.3%

Table A.4 Average weight of consumer goods in a housing unit

(a) Total				
Floor area	Below 69 m^2	70 to 99 m^2	100 m^2 or above	Average
Total	1,018 (79%)	1,432 (88%)	1,594 (89%)	1,216 (84%)
Gas stoves and/or IH cooking heaters	24.59 (71%)	23.39 (78%)	35.46 (49%)	26.53 (66%)
Refrigerators	7.79 (73%)	7.97 (79%)	2.92 (100%)	6.85 (90%)
Dishwashers	1.59 (31%)	2.94 (63%)	9.31 (17%)	3.41 (29%)
Microwave ovens	22.9 (72%)	21.76 (81%)	6 (100%)	19.29 (89%)
CRT TV sets	3.35 (11%)	5.98 (27%)	53.53 (4%)	13.91 (7%)
Flat TV sets	33.06 (72%)	32.47 (86%)	3.89 (100%)	27.1 (99%)
Dressers (Height less than 1 m)	32.81 (64%)	20.67 (83%)	122.29 (24%)	48.28 (45%)
Dressers (Height 1 m to less than 1.5 m)	83.67 (73%)	102.2 (82%)	78.38 (100%)	86.32 (82%)
Dressers (Height 1.5 m or above)	255.55 (92%)	466 (92%)	298.84 (100%)	306.3 (100%)
Cupboard (Height less than 1 m)	50.29 (57%)	25.6 (86%)	165 (27%)	68.29 (44%)
Cupboard (Height 1 m to less than 1.5 m)	47.32 (70%)	80.1 (81%)	100.29 (63%)	64.47 (71%)
Cupboard (Height 1.5 m or above)	62.78 (89%)	111.73 (88%)	36.9 (100%)	67.39 (100%)
Bookshelf (Height less than 1 m)	22.65 (77%)	10.8 (81%)	43.82 (30%)	24.51 (61%)
Bookshelf (Height 1 m to less than 1.5 m)	19.43 (68%)	24.4 (70%)	30.8 (100%)	22.7 (78%)
Bookshelf (Height 1.5 m or above)	19.75 (76%)	56.82 (93%)	24.23 (100%)	28.06 (95%)
Miscellaneous Furniture (Height less than 1 m)	22.79 (86%)	35.98 (90%)	37.02 (100%)	28.28 (91%)
Miscellaneous Furniture (Height 1 m to less than 1.5 m)	16.52 (79%)	17.71 (86%)	47.3 (65%)	22.92 (74%)
Miscellaneous Furniture (Height 1.5 m or above)	18.88 (75%)	21.93 (88%)	45.68 (65%)	24.85 (74%)
Beds	51.77 (78%)	56.77 (88%)	32.89 (100%)	48.99 (100%)
Table sets	64.94 (80%)	86.39 (89%)	136.98 (60%)	83.64 (75%)
Reception sets	130.34 (75%)	168.84 (88%)	245.27 (64%)	161.03 (74%)
Study desks and learning desks	25.35 (81%)	51.36 (91%)	36.76 (100%)	32.83 (96%)
(b) Detached housing				
Floor area	Below 69 m^2	70 to 99 m^2	100 m^2 or above	Average
Total	850 (75%)	1,258 (89%)	1,554 (79%)	1,072 (80%)
Gas stoves and/or IH cooking heaters	25.5 (66%)	21.34 (88%)	36.13 (48%)	26.79 (64%)
Refrigerators	12.47 (63%)	8.55 (83%)	2.73 (100%)	9.74 (78%)
Dishwashers	4.79 (43%)	1.77 (80%)	9.53 (15%)	5.13 (35%)
Microwave ovens	27.22 (70%)	21.29 (86%)	5.07 (100%)	21.61 (87%)
CRT TV sets	0 (0%)	3.74 (67%)	56.54 (4%)	12.06 (8%)
Flat TV sets	53.98 (65%)	35.05 (88%)	1.49 (100%)	39.7 (86%)
Dressers (Height less than 1 m)	75.41 (46%)	29.71 (95%)	153.63 (24%)	81.91 (41%)
Dressers (Height 1 m to less than 1.5 m)	190.79 (76%)	164.22 (81%)	102.43 (100%)	167.8 (82%)
Dressers (Height 1.5 m or above)	101.9 (96%)	180.92 (91%)	116.26 (100%)	120.58 (100%)
Cupboard (Height less than 1 m)	11.92 (60%)	18.69 (100%)	126.92 (25%)	36.27 (40%)
Cupboard (Height 1 m to less than 1.5 m)	10.92 (100%)	161.65 (88%)	161.91 (62%)	71.26 (77%)
Cupboard (Height 1.5 m or above)	56.1 (100%)	79.73 (87%)	30.32 (100%)	55.67 (100%)
Bookshelf (Height less than 1 m)	23.37 (31%)	10.96 (100%)	60.83 (29%)	28.38 (35%)
Bookshelf (Height 1 m to less than 1.5 m)	6.31 (100%)	25.64 (86%)	24.79 (100%)	13.87 (96%)
Bookshelf (Height 1.5 m or above)	7.75 (100%)	64.09 (95%)	29.45 (100%)	23.36 (100%)
Miscellaneous Furniture (Height less than 1 m)	3.12 (100%)	52.95 (95%)	40.9 (100%)	20.64 (98%)
Miscellaneous Furniture (Height 1 m to less than 1.5 m)	13.83 (100%)	15.33 (100%)	36.34 (63%)	18.63 (86%)
Miscellaneous Furniture (Height 1.5 m or above)	5 (100%)	23.96 (91%)	50.41 (64%)	17.88 (77%)
Beds	57.41 (69%)	37.29 (95%)	28.12 (100%)	47.53 (99%)
Table sets	59.66 (96%)	76.35 (89%)	120.38 (58%)	75.14 (82%)
Reception sets	68.47 (71%)	170.39 (90%)	316.19 (62%)	138.4 (72%)
Study desks and learning desks	34.04 (44%)	54.36 (94%)	43.87 (100%)	40.07 (77%)
(c) Complex housing				
Floor area	Below 69 m^2	70 to 99 m^2	100 m^2 or above	Average
Total	1,103 (80%)	1,634 (88%)	1,525 (98%)	1,294 (86%)
Gas stoves and/or IH cooking heaters	23.9 (71%)	24.98 (72%)	23.63 (71%)	24.06 (71%)
Refrigerators	7.05 (74%)	7.52 (76%)	6.38 (80%)	7.01 (76%)
Dishwashers	1.05 (35%)	3.85 (57%)	5.5 (75%)	2.5 (60%)
Microwave ovens	21.37 (71%)	22.13 (76%)	22.5 (67%)	21.75 (71%)
CRT TV sets	3.73 (14%)	7.72 (13%)	0 (0%)	3.78 (13%)
Flat TV sets	30.03 (71%)	30.48 (84%)	46.38 (71%)	33.39 (73%)
Dressers (Height less than 1 m)	13 (82%)	14.05 (71%)	0 (0%)	10.61 (79%)
Dressers (Height 1 m to less than 1.5 m)	37.64 (80%)	57.81 (84%)	62.5 (100%)	46.64 (86%)
Dressers (Height 1.5 m or above)	390.74 (91%)	759.37 (93%)	641.73 (100%)	514.66 (94%)
Cupboard (Height less than 1 m)	83.7 (57%)	32.61 (75%)	81.53 (100%)	73.05 (68%)
Cupboard (Height 1 m to less than 1.5 m)	20.76 (71%)	25.25 (71%)	36.07 (100%)	24.72 (80%)
Cupboard (Height 1.5 m or above)	71.82 (88%)	144.05 (89%)	78.57 (100%)	87.62 (90%)
Bookshelf (Height less than 1 m)	16.23 (79%)	8.58 (71%)	6.13 (100%)	12.68 (80%)
Bookshelf (Height 1 m to less than 1.5 m)	25.53 (69%)	23.26 (54%)	89.47 (100%)	37.86 (82%)
Bookshelf (Height 1.5 m or above)	20.81 (78%)	48.2 (92%)	9.09 (100%)	23.95 (86%)
Miscellaneous Furniture (Height less than 1 m)	23.61 (87%)	23.97 (83%)	47.94 (100%)	28.55 (91%)
Miscellaneous Furniture (Height 1 m to less than 1.5 m)	21.35 (78%)	19.55 (71%)	41.89 (100%)	25.1 (84%)
Miscellaneous Furniture (Height 1.5 m or above)	18.76 (75%)	19.97 (86%)	28.52 (100%)	20.95 (84%)
Beds	63.33 (76%)	76.24 (84%)	50.83 (100%)	63.41 (82%)
Table sets	73.19 (74%)	96.35 (89%)	87.59 (100%)	80.7 (83%)
Reception sets	114.77 (75%)	141.8 (87%)	149.27 (100%)	127.08 (83%)
Study desks and learning desks	21.08 (85%)	46.39 (90%)	9.47 (100%)	23.82 (88%)

Unit: kg/housing

Note: The percentage in parentheses indicates the ratio of consumer goods used on a daily basis.