4. Citizens' Assessment of Vulnerability and Living Environment

It is basically important in examining regional disaster prevention schemes and their directions to understand how citizens are aware of their city's vulnerability to disasters. In bringing the disaster prevention measures in practice, such knowledge becomes useful information. In this chapter, selecting five urban areas worldwide as case study areas and conducting a questionnaire survey to the public, we investigated citizens' awareness of disaster risks, living environment, and attitude to disaster prevention.

The survey covered the following five cities where earthquake disasters are likely to occur.

(1) Ankara (capital of Turkey): municipal population 2.54 million (1989)
(2) Manila (capital of the Philippines): municipal population 1.86 million (1989)
(3) Mexico City (capital of Mexico): municipal population 18.75 million (1986)
(4) Wellington (capital of New Zealand): municipal population 140,000 (1988)
(5) Ichikawa City, Chiba Prefecture (a suburban city of Metropolitan Tokyo): municipal population 430,000 (1989)

Among these cities, Mexico City most recently suffered from an earthquake disaster in 1987.

4.1 Outline of Questionnaire Survey

The survey in Ichikawa City was conducted in September 1992. That in the other four cities was conducted from September 1992 to January 1993. The following persons kindly cooperated with the survey in the overseas cities. The survey probably could not have been conducted without their assistance.

Ankara City: Rusen Keles, Professor, Faculty of Political Science,
Ankara University.
Manila City: Rommel C. Gavieta, Research Fellow, College of Architecture,
University of the Philippine.
Mexico City: Tanaka Michiko, Professor, Faculty of Japanese Studies,
University of Mexico.
Wellington City: John Taber, Researcher, Institute of Geophysics,
Victoria University of Wellington.

The method of sampling the subjects in the other(foreign) four cities was different from in the case of Ichikawa city. In the foreign cities, the typical three areas due to social classes of inhabitants, namely high, middle and low from the socio-economic viewpoint, were selected as the survey areas. In Ichikawa city, questionnaires were mailed to 5,000 randomly selected subjects and recovered by mail.

The recovery rate was 98% (148) in Ankara, 100% (120) in Manila, 99% (95) in Mexico City, 100% (90) in Wellington and 46.2% (2,251) in Ichikawa.

The questionnaire was prepared in Japanese and English. Table 4-1-1 shows the contents of it.

Table 4.1.1
Contents of Quetionnare Survy

Item	Contents
Occurence of Earthquake	Do you believe that a devastating earthquake hits your city in less than 20 years ?
Fearful Damage due to an Earthquake	Which items are the most hazardous to local population? How do you assess a safety of each item ? ; Your own dwelling, Playground, Parks & Green areas, Schools, High-rise building, etc.
Life Style	Do you depend on such items ? ; Water Supply, Piped Gas, Toilet, Stock of Food, Radio on batteries and Moter Vehicle.
Evaluation of Daily Living Environment	Building Density, Sunshine, Natural Lighting, Flow of Air, Width of Streets, Air Quality, Neighborhood Relationships, etc.
Assessment of Environmental Safety	Fire, Earthquake Generated Fire, Flood, Building Damage, Landslide, Evacuation, Explosion of Inflammable Material, Neighborhood Relationships in a disaster, etc.
Attributes of Houses	Age of houses, Floor area of Dwellings, Construction type of houses
Attributes of Family	Size of Family, Number of Infants, the Aged, Disabled, etc.
Attributes of Respondent	Age, Sex, Occupation, Period of dwelling, Experience of Disaster.

4.2 Comparison of Social Structure

4.2.1 The Respondents' Attributes

(1) The respondents' age composition

There were many young people in the developing regions. The age composition in the civilized regions was evenly distributed. In Mexico City, Ankara and Manila, young people of age under 40 accounted for 85%, 79% and 72% of the respondents, respectively.

(2) The respondents' sex composition

There were slightly more females in Mexico City and Ankara (60%). There were equal numbers in Manila. 56% were males in Wellington.

(3) The respondents' occupational composition

Occupation was represented by "job category" and "occupation." The occupational composition clearly showed the difference in the socio-economic conditions between the developing and civilized regions.

As for "job category", numerous in the developing regions were "self-employed (small business)". In Manila, they accounted for as much as slightly over 36%. They reached 30% in Mexico City and 20% in Ankara. In contrast, they reached only slightly under 8% in Wellington and 9% in Ichikawa as the civilized regions.

As for "occupation", the occupational component ratio was calculated by excluding unclassifiable responses. The results show that the respondents' occupational composition reflects the region's socio-economic conditions to some degree. This for example is relative scarcity of those engaged in manufacturing and services and relative abundance of those

engaged in commerce and government services in developing regions.

(3) Term of residence in their neighborhood

The length of residence in this neighborhood was slightly longer in Ankara, Manila and Mexico City than in Wellington and Ichikawa. The ratio of those residing for less than two years was 4.1% in Manila, 10.8% in Mexico City and 15.0% in Ankara. In contrast, it was 20.3% in Ichikawa and 25.6% in Wellington.

By the social areas, it was interesting that in both Manila and Mexico City, the ratio of those residing for many years was relatively high in the areas of the low and high classes. In Ankara, it was particularly high in the area of the low class. Generally, while the mobility was relatively high among the middle classes, it was low among the low classes in developing countries.

(4) Experience of disasters

While 78.2% and 73.4% of the respondents in Manila and Mexico City had experienced disasters, only 38.2% in Wellington, 37.3% in Ichikawa and 23.4% in Ankara had experienced disasters.

The kinds of disasters experienced depended on the city's natural conditions. The kinds of disasters pointed out by the most numerous men of experience in each city were as follows.

Ankara: Earthquake (41.2%), fire (23.5), flood (20.6)
Manila: Riot and terrorism (33.4), earthquake (32.3), flood (25.8)
Mexico City: Earthquake (88.4), flood (4.4)
Wellington: Riot and terrorism (20.6), war (20.6), flood (17.6), earthquake (14.7)
Ichikawa: Flood (46.9), war (36.2), other natural disasters (11.8), fire (10.7)

4.2.2 Attributes of The Respondents' Households

(1) Household size

The size of the respondents' household was relatively large in developing countries and small in civilized countries.

The size of them was particularly large in Manila, where 57.5% of them lived in households comprised six to ten members. The household size was small in Ichikawa. 19.1% of them lived alone and 20.2% in a family of two. In Wellington also, 15.6% of them lived alone and 33.3% in a family of two.

(2) Presence of persons vulnerable to disasters

<Infants>

Presence of those vulnerable to disasters such as infants, children, aged, physically handicapped and sick in a family is able to aggravate the potential vulnerability to disasters not only in their families but also in their neighborhood(Table 4-2-1).

The ratio of the households having infants of age 0 was high in Manila at 14.2% and Ankara at 13.0%. These were followed by 6.7% in Wellington, 3.8% in Ichikawa and 1.1% in Mexico City. In Manila where there were gigantic families of over 20 members, it requires a note that some families had three infants of age zero.

The ratio of the households having infants of age 1-2 was overwhelmingly high in Manila at 24.3%. This was followed by 10.5% in Mexico City, 8.8% in Ankara, 5.9% in Ichikawa and 5.6% in Wellington.

Table 4.2.1
Percemtage of Families with Infant

Infants	Ankara	Manila	Mexico C.	Wellington	Ichikawa
0 to 12 Months	13.0	14.2	1.1	6.7	3.8
1 or 2 years old	8.8	24.3	10.5	5.6	5.9
3 to 5 years old	33.6	33.3	14.7	12.2	8.9
65 years & over	15.5	21.7	14.7	25.6	17.2
Physically handicapped	1.3	7.5	1.1	5.6	2.9
Suffering from illness	12.8	6.7	4.2	4.4	1.0

The ratio of the households having infants of age 3-5 was decisively high in Ankara at 33.7% and Manila at 33.3%. These were followed by 14.8% in Mexico City, 12.3% in Wellington and 8.9% in Ichikawa.

In terms of total infants (age 0 to 5), almost every household had infants in Ankara and Manila. Moreover, in terms of social class, the lower the household, the higher the ratio of having infants. For example, in Ankara, the ratio of the households having infants was 61.2% in the area of low class, 47.9% in the area of middle class and 26.5% in the area of high class. In Manila also, the figures were 72.4% (low), 50.0% (middle) and 23.3% (high).

<Aged population>

In terms of aged household members (over age 65), the ratio was the highest in Wellington at 25.6%, which was followed by 21.7% in Manila, 17.2% in Ichikawa, 15.5% in Ankara and 14.7% in Mexico City. This is a reflection of the progress of the aging of the society in the civilized countries. The high ratio in Manila was remarkable in particular.

Unlike the case of infants, the lower the social class in Ankara and Manila, the households having aged members were the fewer.

<Physically handicapped and sick members>

The ratio of households having physically handicapped members was 7.5% in Manila, followed by 5.6% in Wellington, 2.9% in Ichikawa, 1.1% in Mexico City and 0.9% in Ankara.

As in the case of infants, the ratio of those having sick family members was high in developing regions. Moreover, it is remarkable that the ratio of having sick members was higher than that of having physically handicapped members. The ratio of those having sick household members was 12.8% in Ankara, 6.7% in Manila and 4.2% in Mexico City. It was 4.4% in Wellington and 1.0% in Ichikawa.

(3) Daytime population in household

The daytime population of suburban residential areas of cities in civilized countries is characterized by a high composition of infants, aged persons and housewives which is vulnerable to disasters. Their working places are far away from their dwelling places in these cities. In fact, the ratio of the respondents saying that "nobody is at home in a daytime" was 35.7% in Ichikawa and 31.1% in Wellington. While the ratio of those saying that "somebody at home in a daytime" was 46.3% in Ichikawa and 67.8% in Wellington, it was 72.8% in Ankara, 83.0% in Mexico City and as high as 93.3% in Manila.

This means that there are the vulnerability of man-power for disaster mitigation in a residential area of daytime in developing countries rather than in civilized countries.

4.2.3 Housing Types

(1) Age of Buildings

Regardless of the type of structure, old buildings are more vulnerable to earthquake disasters. In terms of the age of buildings which means "years since constructed", there were relatively many new houses in Manila and Ichikawa. The ratio of new houses constructed within 10 years was 41.6% in Manila and 39.7% in Ichikawa. The ratio of those constructed within 20 years was 77.5% in Ichikawa, 71.6% in Manila, 56.1% in Ankara and 53.7% even in Mexico City. In contrast, the ratio of old houses was high in Wellington. As many as 67.1% of the houses were constructed before over 31 years. In Mexico City also, 33.7% of the houses were constructed before over 31 years.

By social class, in Manila where there were many new houses, the houses of higher class families were relatively older and those of lower class were newer. The situation was the opposite in Mexico City and Ankara. The higher the social class, the newer the houses, and the lower the social class, the older the houses. There was no difference among the ages of houses of each social class in Ichikawa and Wellington.

(2) Size of a dwelling unit

The size of dwelling houses was represented by the house's total floor area. It was notable that the houses were the smallest in Ichikawa. Even by taking account of the smallness of family size, it cannot be denied that the level of housing in Japanese metropolises is low. In terms of the ratio of houses with floor areas of over 100m2, it was 61.1% in Wellington, 58.3% in Manila, 52.6% in Mexico City and 37.0% in Ankara. That in Ichikawa was only 26.7%. In comparison to Wellington, the house size in Ankara, Manila and Mexico City is not necessarily small. It is considered in Ichikawa that the risk of falling of furnitures in an earthquake disaster is estimated to be the highest, because many furnitures are placed in the houses despite their small houses.

By social class, the higher the class, the larger the houses. In Manila and Mexico City in particular, there was great difference in house size by social class.

(3) Structure of housing

The materials and style of housing construction varies from one region to another and greatly affects the degree of damage in an earthquake. Table 4–2–2 shows the composition of housing structure types.

Table 4.2.2
Comparison of Construction Type of Dwellings (%)

Construction Type	Ankara	Manila	Mexico C.	Wellington	Ichikawa
Unreinforced Masonry (Brick, Stone, etc.)	54.5	0.9	3.2	–	1.8
Wood Frame (with various Walls)	1.4	7.9	–	82.1	55.3
Reinforced Concrete Frame	25.2	90.4	88.4	7.1	28.5
Steel Frame (with various Walls)	–	0.9	5.3	–	12.9
Others	18.9	–	3.2	10.7	–

In Ichikawa, houses are traditionally made of wood frames. New houses however are often constructed by reinforced concrete or steel frames so that diverse structures of houses are found. In contrast, in Wellington, the most numerous houses were by wood frame. In Manila and Mexico City, the structure of houses was reinforced concrete frames with light

internal and external block walls. In Ankara, many of the houses were made of concrete blocks in addition to reinforced concrete frame as above.

Such characteristics of housing structure are greatly related with building vulnerability in an earthquake disaster. Simply put, in the cities of developing regions , there are many non-wooden houses of high density constructed by low cost which of the seismic capacity is lower than wooden. Such housing construction style is increasing the risk of building collapse due to the first shake of earthquake and large human loss in developing countries.

In terms of social class, the only difference was found in Ankara. There, middle and low class respondents often lived in concrete block houses and high class respondents in reinforced concrete frame houses with light internal and external block walls.

4.2.4 Life Style

(1) Life line service

<Water supply>

The ratio of the houses supplied water was 100% in Wellington, 98.7% in Ankara, 97.9% in Mexico City, 97.3% in Ichikawa and 83.2% in Manila. This includes use of both well and water supply. In terms of the ratio who can use wells, it was high in Manila at 28.6% (well only: 16.8%), followed by 7.4% in Mexico City, 5.9% in Ichikawa, 2.8% in Ankara and 0% in Wellington. Taking the damage of life line in an earthquake disaster into consideration, the ability to use wells is advantageous for temporary living after the disaster.

In terms of "water outlets or faucets in own dwelling unit," the situation in Ankara was characteristic. There, as many as 57.2% of the families did not have water outlets or faucets in their own houses. They were more numerous the lower the social class.

<Energy>

There was great difference among the cities in terms of use of piped gas. Many dwellers in Ichikawa used piped gas at 75.1%. This was followed by 58.9% in Wellington and 53.4% in Ankara.

The ratio of the families using LPG was 100% in Mexico City and 86.7% in Manila. It was 45.3% in Ankara and 21.7% in Ichikawa. In terms of social class, in Ankara, all families of low class used LPG.

In Wellington, the ratio of the families not using gas reached 38.9%. It was 13.3% in Manila. By social class, many of the middle and low class did not use gas in Wellington and many of the low class did not use gas in Manila.

<Toilet>

The rate of use of flush toilets varied among the cities. Flush toilets had been used in Wellington at 100%, followed by 79.6% in Ankara, 74.5% in Mexico City and 50.9% in Ichikawa. In Manila, the figure was as low as 26.7%. The ratio of the families using flush toilets connected to private sewage treatment tanks was the highest in Manila at 73.3%. 55.8% of the families also used flush toilets connected to community sewage systems. In Ichikawa also, 42.7% of the users of flush toilets connected to private sewage treatment tanks. While few houses did not have toilets, in Ankara, 13.6% of the families did not have toilets in their own houses. From the viewpoint of the daily sanitary environment, the spread of flush toilets is desirable. But this causes a vulnerable situation in an earthquake disaster,because the people cannot use the flush toilets, if water supply is suspended by an earthquake disaster.

(2) Possibility of personal response to disasters

<Food>

The ratio of the families stocking food was low in Ichikawa and high in Manila and Wellington. Those not stocking food reached 41.9% in Ichikawa, 36.6% in Ankara and 28.4% even in Mexico City, while the ratio of families stoking food reached 87.8% in Wellington and 82.5% in Manila. In terms of the amount stocked, that in Ichikawa also was small. In other cities, many of the respondents who stocked food expected to live on it for a week or two.

<Access to disaster information>

As a means of collecting information in a disaster, battery-powered radio sets are important. Their spread rate was high in every city.

<Motor vehicles>

The rate of ownership of motor vehicles was very high. It was the highest in Wellington at 82.0% followed by 66.3% in Mexico City, 64.7% in Manila, 62.2% in Ichikawa and 54.1% in Ankara.

Automobiles have greatly spread even in developing regions. It is considered in civilized countries that the congestion of automobile traffic in a disaster could become a serious problem. On the other hand, if well controlled, automobile traffic is indispensable as an important means of transportation in a disaster. Automobile ownership is also effective as a means of collecting information from car radios.

4.2.5 Vulnerability of Social Structure and Direction of Countermeasures

When the foregoing attributes of households and houses are assessed from the viewpoint of vulnerability of urban dwellers in an earthquake disaster, the following characteristics can be pointed out regarding a comparison between civilized and developing regions.

(1) Reflecting the economic structure of various regions, while civilized regions comprise an "employment society" centered around large enterprises, the developing regions comprise a "self-employed society" made up of many small businesses. Because of this, in such regions, damage to buildings directly deprive citizens of the means of economy and living.

(2) Compared with civilized regions, concentration of population to cities has progressed more rapidly in developing countries. This is understood to have aggravated the shortage of housing. Yet the mobility inside cities is higher in civilized than in developing regions. If this means high stability of urban residence in developing regions, the high degree of permanent residence in each region can be considered to have made the neighborhood relations close. This permanence of residence and closeness of neighborhood relations comprise important social resources which could contribute toward developing the capacity to cope with disasters.

(3) The ratio of those who had experienced disasters was higher in developing regions. Such experience could enhance the awareness for disaster prevention and promote the implementation of disaster prevention measures. On the other hand, it could also have people develop a sense of resignation toward disasters. Therefore, the important issue will be the methodology for having the experience of disaster work in the direction of promoting disaster prevention measures both personally and socially.

(4) The household size was large in developing regions. Moreover, the ratio of those having infants and sick persons was very high. In contrast, the ratio of those having aged family

members was higher in the developed regions. Hence, the household structure in the developing regions is vulnerable made up of many who are vulnerable to disasters. This is a characteristic to be fully noted when taking disaster prevention measures in developing regions.

(5) In the suburban residential areas of major cities of civilized regions, the daytime population is made up of many who are vulnerable to disasters such as children, women and the aged because of absence of the household heads who are commuters. As a result, with the increase of the homecoming distance of urban commuters, the problem of homecoming traffic in a disaster becomes a serious one. In contrast, in developing regions, there is a strong tendency for people to live and work in the same place. Hence, there is no major difference in the region's daytime and nighttime population structure. This means that in developing countries, even if disasters break out during daytime, the capacity for the people to cope with disasters in each area, has been maintained. This could be a condition advantageous for the developing region from the viewpoint of human response to cope with disasters.

(6) As for the size of housing, Japan's was the smallest. Yet in developing regions, the rapid population increase and the tightness of housing supply accelerated the supply of reinforced concrete apartment complexes of standards much lower than those in civilized regions. Such housing of low seismic capacity (or vulnerability) increases so rapidly that the building damage in earthquake disasters becomes more and more serious. Moreover, the large number of those vulnerable to disasters and the high population density will increase human loss and building damages.

(7) Life line infrastructures have spread in major cities of developing regions also. Therefore, even in such regions, urban life has rapidly been reducing its self-sufficiency of life. This has aggravated the seriousness of suspension of urban residential life, that means the new vulnerability of urban disaster.

(8) The automobiles have spread at a pace higher in developing countries than in major Japanese cities. There is great possibility of occurrence of risky states due to traffic congestion.

(9) The rate of spread of battery-powered radios is very high. If stocking and supply of batteries can be ensured, they can fully be utilized even in developing regions as a means of access to information in disasters.

(10) In terms of the state of stocking of food, the households in the major city in Japan (Ichikawa) seem to be stocking the least (by reflecting the smallness of houses and the development of higher distribution system).

4.3 Forecast of Earthquake Disaster Damage

4.3.1 Residents' Forecast of Earthquake

According to the results of the respondents' forecast of occurrence of a devastating earthquake in less than 20 years, the respondents of Mexico City which suffered from earthquake damage in 1985 most predicted another earthquake (74.7%). This was followed by 60.8% in Manila, 53.8% in Ichikawa and 50.0% in Wellington. Only 2.7% of citizens forecast earthquake in Ankara. On the hazard map of 1972, Ankara has been assessed as zone 4th, that means less risks among five zones. 86.5% of its citizens did not think that it would be hit by an earthquake in less than 20 years.

4.3.2 Earthquake Damage Based on Citizens' Assessment of Risks

Table 4-3-1 shows the most serious earthquake damage recognized by citizens regarding their cities. It shows great difference between Japan (Ichikawa) and the foreign

regions in terms of the items feared as serious damage.

In Japan, the most fearful damage was earthquake generated fire (63.1%). In the other four cities overseas, it was building collapse. Moreover, while there are many wooden houses in Wellington, the ratio of fire was not so high.

The highest rate was the building collapse at 64.6% in Wellington. It was higher in the three cities in the developing regions at from 78% to 88% than in Wellington.

Table 4-3-1
Damages feared by citizens in an earthquake disaster

City	Most	Second	Third	Fourth
Ankara	Building Collapse (77.7%)	Narrow Streets Blocked by Debris (45.9%)	Damage of Utility Poles (39.2%)	Lack of Information and Demagogue (33.1%)
Manila	Building Collapse (83.3%)	Damage of Utility Poles (39.2%)	Risks of Toxic/ Inflammable Material (22.5%)	Narrow Streets Blocked by Debris (17.5%)
Mexico City	Building Collapse (88.4%)	Lack of Info. and Demagogue (52.6%)	Risks of Toxic/ Inflammable Material (43.2%)	Damage of Utility Poles (30.5%)
Wellington	Building Collapse (64.4%)	Damage of Utility Poles (44.4%)	Risks of Toxic/ Inflammable Material (43.3%)	Lack of Info. and Demagogue (37.8%)
Ichikawa	Earthquake Generated Fire(63.1%)	Shortage of Food and Water (55.3%)	Building Collapse (44.4%)	Collapse of Stone/ Concrete-block Walls (31.7%)

An fearful item of the next in Japan was food and water shortage (55.3%), followed by building collapse (44.4%) and collapse of stone/concrete-block walls (31.7%). Certainly, as seen in the previous section, the respondents of Ichikawa stocked food in their houses the least. Hence, they are greatly anxious about food and water. The respondents in the four foreign cities pointed out damage to utility poles (suspension of electricity), explosion of hazardous materials and leaking of toxic gasses, confusion due to lack of information and demagogue and narrow streets blocked by debris. Yet few people feared earthquake generated fire or food and water shortage. There is a contrastive aspects of an earthquake damage between in Japan and the others.

4.3.3 Citizens' Awareness of Earthquake Disasters Through Their Assessment of Safety of Urban Facilities

Table 4-3-2 shows the urban spaces which are considered to be safe in an earthquake. The figures are the ratio of those who considered these to be safe.

Table 4–3–2
Safety Assessment of Urban Facilities (%)

Urban Facilities	Ankara	Manila	Mexico C.	Wellington	Ichikawa	Average
Parks and Green Areas	+ 85.0	+ 75.8	+ 87.4	+ 74.4	+ 83.7	81.3
Playground/Small parks	+ 59.0	+ 57.5	+ 53.7	+ 64.4	(7) 16.2	50.2
Your Own Dwelling	20.3	+ 67.5	+ 59.0	+ 66.7	23.9	47.5
Roads, for a Walker	38.1	47.5	34.7	39.3	(4) 5.0	32.9
Schools	23.0	22.0	22.3	43.3	+ 50.2	32.2
Cars and Buses	24.3	23.5	24.5	30.0	(2) 4.7	21.4
Public Buildings	21.0	(2) 5.0	(1) 9.5	25.6	26.7	17.6
Trains except Subways	(3)17.0	(5) 9.3	34.7	(4) 12.5	(3) 4.8	15.7
Subways(in a Coarch)	(4) 19.9	(3) 5.5	21.1	–	(5) 7.0	13.4
Underground Malls	23.0	(1) 4.4	(3) 19.0	(3) 9.0	(6) 10.0	13.1
Shopping and Amusement	(1) 2.7	(6) 11.7	37.2	(1) 7.8	(1) 0.4	12.0
High–rise Buildings	(2) 3.4	(4) 5.9	(2) 12.8	(2) 7.9	22 0	10.4

Notes: Figure (1) – (7) shows the items of lower safety by under 20% and their order. " + " shows the items of higher safety by over 50%.

(1) The people generally consider open space facilities as safe. On the contrary, they did not consider safe places such as trains, underground malls, shopping and amusement quarters and high–rise buildings which become congested in the central district of a city.

(2) The citizens' assessment of the safety of "small open spaces including playgrounds close to dwellings" was low in Ichikawa(Japan) and high in foreign cities. The reason of difference was that while dwellers particularly of developing regions considered these small spaces as places of refuge from building collapse, these small spaces were considered to be unsafe in the event of an urban fire in Japan.

(3) The citizens' assessment of safety of roads, cars and buses and trains was also similarly low in Japan and high in foreign cities. In Japan, the risk of falling objects from buildings is lowering the safety of roads.

(4) The citizens' assessment of safety of schools and public buildings including government offices was low in developing countries and high in civilized countries. In developing countries, fearful damage was building collapse including public facilities.

(5) The citizens' assessment of safety of high–rise buildings was low in Wellington and relatively high in Japan.

(6) Many of the citizens in Mexico City had experienced the Mexico earthquake of 1985. They hence assessed urban safety based on their experience. The results of their assessment therefore set forth the patterns of earthquake disasters in developing regions. They feared the low safety of public buildings including government offices, high–rise buildings, underground malls, subways and schools. These were followed by cars and buses, trains, roads and shopping and amusement quarters. In contrast, the majority of them evaluated the safety of small open spaces including playgrounds, their own dwellings and spacious open spaces including parks and green areas. This tendency was common not only among Manila and Ankara respondents but Wellington respondents.

(7) According to citizens' awareness in Ichikawa, the patterns of Japanese earthquake disaster are as follows. The very fearful places were shopping and amusement quarters, cars and buses, trains, roads and subways, followed by underground malls, small open spaces including playgrounds, high–rise buildings and own dwellings. Under 24% of them considered above items to be safe. Citizen who considered public buildings including government offices to be safe were only 26.7%. The majority of citizens in Ichikawa believed the safety of only schools and spacious open spaces including parks and green areas.

(8) The difference of fearful items of earthquake disasters between Japanese and four foreign cities were caused by the differences in their urban conditions. The buildings' seismic capacity and the patterns of damage from earthquake disasters (damage aspects) were imagined from past earthquake disasters occurred in each country.

4.4 Assessment of Environment and Safety from Disasters

Basically, urban areas endowed with good daily living environment can be said to be safe in a disaster. Urban areas which living environment is poor are often risky and highly vulnerable to disasters. And such environment is changed by the activities of the human beings and their behaviors in daily life.

Disaster prevention measures can only be executed when they are accepted by citizens on a daily basis. The city's safety capacity is thus strengthened through the daily life of citizen.

4.4.1 Evaluation of Daily Living Environment

Table 4-4-1 shows the results of having citizens' evaluation of the quality of their living environment using a five-step scale. These are the results of self-evaluation regarding the varies items of their own cities. The environmental standards which satisfy residents depend on the quality of citizens' life in each city. Therefore, the degree of satisfaction does not directly reflect the degree of environmental standards. Dissatisfaction however may be indicative of the necessity to improve the environment in each city.

(1) The residents of every city generally lowly evaluated noise and vibration, pollution and road conditions. They highly evaluated items were natural lighting, flow of air and sunshine.

(2) In terms of comparison among the cities, the residents of Wellington were the most satisfied about the living environment items. In terms of the overall evaluation of living environment, the Wellington's citizens were overwhelmingly satisfied, in contrast with the dissatisfaction in Ichikawa, Manila and Mexico City.

(3) Compared with Wellington, the environmental evaluation in Ichikawa was more or less on the same level as that in Ankara, Manila and Mexico City, though Ichikawa is a suburban area of Tokyo Metropolitan region. Based on the findings shown in this table, it must be said that as far as evaluation of the daily living environment is concerned, Japanese cities are no different from the cities in developing regions.

(4) Among the five cities, the Mexico City respondents were remarkable to be satisfied the least. Dissatisfied items were air pollution, building density, open spaces, noise and vibration, vegetation and accessibility to parks and green areas.

(5) However, it was road width and traffic safety that citizens were the least satisfied about in Ichikawa.

(6) The degree of satisfaction about neighborhood relationship was high in Manila and Mexico City and the lowest in Ichikawa.

Table 4–4–1
Evaluation of Daily Living Environment of Neighborhood

Itmens of Daily Living Environment	Ankara	Manila	Mex. C.	Wellington	Ichikawa	Average
Noise and Vibration	- 8.8	7.4	- 26.5	43 2	1.2	3.3
Air Quality (Smell,Dust,Emission)	2.1	24.0	-110.6	108.9	- 6.3	3.6
Width of Streets	- 6.9	8.6	6 4	68.4	- 47 9	5.7
Traffic Safety	- 8.1	40.8	- 11.5	42.3	- 30.9	6.5
Open Spaces (Parkas,Grounds,etc.)	- 13.6	1.7	- 56.7	102.1	8.5	6.7
Building Density	- 7.4	42.5	- 57.8	71.1	14.7	12.6
Vegetation, Amount of "Green"	8.9	9.9	- 11.6	110.1	19.1	27.3
Accessibility to Public Open Space	40.5	15.8	0.0	131.0	21.2	41.7
Neighborhood Relationships	53.6	105.7	40.1	102.3	21.7	64.7
Flow of Air	47.4	65.1	77.7	152.2	68.8	82.2
Natural Lighting (in a room)	55.3	83.3	75.7	127.9	-	85.6
Sunshine (in a room)	86.5	115.0	47.3	122.2	-	92.8
Overall Evaluation of Environment	24 2	50.9	35.7	103.4	30.1	48.9

Notes: Each item was scored by giving 2 to "Excellent," 1 to "Good," 0 to "Fair," -1 to "Poor" and -2 to "Very Poor." The scores were added by loading to the component ratios of evaluation in each city. Therefore, the positive and greater the score, the better the evaluation, and the negative and the greater the absolute number of score, the poorer the evaluation.

4.4.2 Assessment of Environmental Safety Against Disasters

Similarly, the respondents were asked to assess the safety (or vulnerability) of their living areas in the event of a disaster using five steps scale. Table 4–4–2 shows the results.

(1) In terms of the overall assessment of environmental safety, the citizens were the most satisfied in Wellington, followed by Manila, Mexico City and Ankara. The Ichikawa's citizens were the least satisfied.

(2) The Wellington's citizens were relatively more satisfied with the many items also, in the comparison among cities.

(3) In the comparison among cities, the citizens of Ankara and Ichikawa were the least satisfied with the greatest amount of the items. The items of building damage, earthquake generated fire, evacuation and explosion and leakage of hazardous materials were feared in Ankara. The items of sinking and slide of building site, especially earthquake generated fire, building damage and disruption of neighborhood relationship were feared in Ichikawa.

(4) In terms of comparison among the items, the citizens of five cities commonly highly evaluated the safety from flood due to failure of embankments and the safety from landslides. These are determined by not general but local factors of geographical and other natural conditions.

(5) While safety from earthquake generated fire, building damage due to an earthquake, fire, evacuation and flood due to heavy rain concerned not local but all cities, the evaluation score of these items was generally low.

(6) There was no difference among the scores given for earthquake generated fire and building damage due to an earthquake, whose items of both were evaluated as the lowest. In the survey of experts analyzed in Chapter 2, it was considered that building damage would be more of a problem than earthquake generated fire in foreign earthquake disasters not in Japan. However, according to citizens' assessment, they also feared earthquake generated fire.

(7) While earthquake generated fire and building damage were generally feared the most, they were feared in Ankara followed by Ichikawa and Mexico City in terms of inter–city comparison. They were least feared in Manila.

(8) The citizens of Mexico City did not fear the disruption of neighborhood relationship. Its score was the highest at 106.0. Among the four foreign cities, the citizens of Ankara most feared this item at 64.6. In contrast, this item were feared in Ichikawa at −6.8. In the suburban residential areas of Japanese major cities, the neighborhood relationship is markedly weak both in daily life and in a disaster.

4.4.3 Vulnerability to Disasters Based on Citizens' Safety Evaluation

Based on Table 4−4−2, the description of each city's vulnerability to disasters was examined through its citizens' evaluation from the city of the lowest score of overall safety evaluation in order. This vulnerability are reflected from each city's disaster image held by its citizens.

Table 4−4−2
Assessment of Environmental Safety in Neighborhood

Itmens of Environmental Safety	Ankara	Manila	Mex. C.	Wellington	Ichikawa	Average
SAFETY FROM						
Earthquake Generated Fire	− 30.3	45.0	− 14 7	5.6	− 20.4	3.0
Building Damage due to Earthquake	− 37.4	63.9	− 4.3	22 1	− 18.8	5.1
Fire, (excpet Earthquake Fire)	− 5.3	36.7	− 10.7	71.0	− 12.9	15.8
Safety in Evacuation m a Disaster	− 0.5	41.3	10.6	48.8	7.8	21.6
Flood due to Heavy Rainfall	44.0	23.4	24.3	81 0	15.9	37.7
Flood Tide	−	52.6	−	27.7	55.8	45 4
Risks of Inflammable Material	− 1.4	61.4	68.5	68.5	33.2	46 0
Shinking of Building Sites	63.5	66.7	61.1	83.5	− 26.4	49.7
Disruption of Neighbors' Relations	64 6	84 9	106 0	93 0	− 6.8	68.3
Flood due to Failure of Embankment	89.5	48.2	130.6	112.4	52.8	86.7
Landslide	83.7	139.9	187.2	148.9	103.3	132.6
Overall assessment of Safety	22.1	48.8	31.8	69.9	6.8	35.9

Notes: Each item was scored by giving 2 to "Excellent (Safe)," 1 to "Good," 0 to "Fair," −1 to "Poor" and −2 to "Very Poor (Dangerous)." The scores were added by loading to the component ratios of evaluation in each city. Therefore, the positive and greater the score, the better (safer) the evaluation, and the negative and the greater the absolute number of score, the poorer (more dangerous) the evaluation.

<Ichikawa>

The citizens feared sinking and slides of building site, earthquake generated fire, building damage due to an earthquake, fire and disruption of neighborhood relationship. They also feared safety in evacuation in a disaster, flood due to heavy rainfall, explosion of hazardous materials, flood due to failure of embankments and flood tide. They more feared earthquake disasters they have not experienced than flood which occurred every year in spite of locally. Fearfulness of earthquake is a result of disaster education and spread of knowledge.

<Ankara>

The citizens feared building damage due to an earthquake, earthquake generated fire, fire, explosion of hazardous materials and evacuation. Even in Ankara where very few of the respondents felt that they would be hit by an earthquake in a near future (in less than 20 years), they feared earthquake disasters and fire. Ankara however is located in a dry region and even a little rainfall causes urban floods and small landslides. Its respondents however were not so anxious about weather disasters. Yet the Gecekondus which are said to account for 70% of Ankara's housing are developed illegal housing. It characterizes the townscape of Turkey and comprises private development on steep slopes which are dangerous to landslide. The experts has pointed out that building site disasters such as landslides have becomes a serious issue.

<Mexico City>

The most fearful items were earthquake generated fire, fire and building damage due to an earthquake. These were followed by evacuation and flood due to heavy rain. Mexico City basically expanded by reclaiming a lake. Hence, while the citizens felt the risk of flood in the rainy season, they did not feel much risk of landslides. However, the progress of urbanization on slopes around large cities must be involving the problem of landslides. While many felt the risk of building damage due to an earthquake (−4.3), many felt their own dwelling to be safe. This is indicative of the subconscious evaluation among citizens that disasters were not their problem but others'. Such a structure of consciousness becomes a great obstacle in implementing disaster prevention measures.

<Manila>

None of the scores were negative. The majority of the citizens did not feel so risky in their residential environment. The items with relatively low scores(not so safe items) were flood due to heavy rainfall, fire, evacuation, earthquake generated fire, flood due to failure of embankments, flood tide, explosion of hazardous materials, building damage due to an earthquake and sinking of building site. While the citizens most feared earthquake disasters among the various disasters, in terms of assessment of safety of urban environment, they feared weather disasters such as typhoons and fires which occur every year.

<Wellington>

Here also, none of the scores were negative. Scored the lowest was earthquake generated fire. This was followed by building damage, flood tide and evacuation. The citizens strongly identified that Wellington was safe from natural disasters, though the active faults are exposed on the surface of urban areas. In addition to this, because there are many wooden houses, an earthquake generated fire is the only thing they fear.

4.4.4 Relationship Between Residential and Safety Qualities of Urban Environment

(1) Relationship between evaluation of living environment and assessment of safety

Figure 4−4−1 shows the relationship for each city between the scores of the overall evaluation of the living environment and those of the overall assessment of environmental safety in a disaster. While the levels at which each city's citizens are satisfied differ each other, it requires attention that through the assessment of both the daily living environment and the safety against a disaster, the quality of the urban environment of large cities of Japan (represented by Ichikawa) was the poorest in terms of citizens' level of satisfaction. As regards the other items also, there was correlation between the quality (good and bad) of the daily living environment and the quality (high and low) of safety in a disaster.

(2) Evaluation of neighborhood relationship, daily and in a disaster

The neighborhood relationship in the area of residence was asked by distinguishing between daily relationship and possibility of mutual help in a disaster. Figure 4−4−2 shows the distribution of the scores per city. The citizens of Mexico City who actually experienced the earthquake disaster in 1985 highly evaluated mutual help in a disaster as against daily neighborhood relationship. In the other cities except Mexico City, the daily neighborhood relationship and that in a disaster are strongly related. Moreover, compared with the low score in Japan, in large cities of developing countries where the residents settled longer in every neighborhood, they have formed neighborhood relations closer than in Japan. This can be said to have formed community relationship advantageous in coping with disasters.

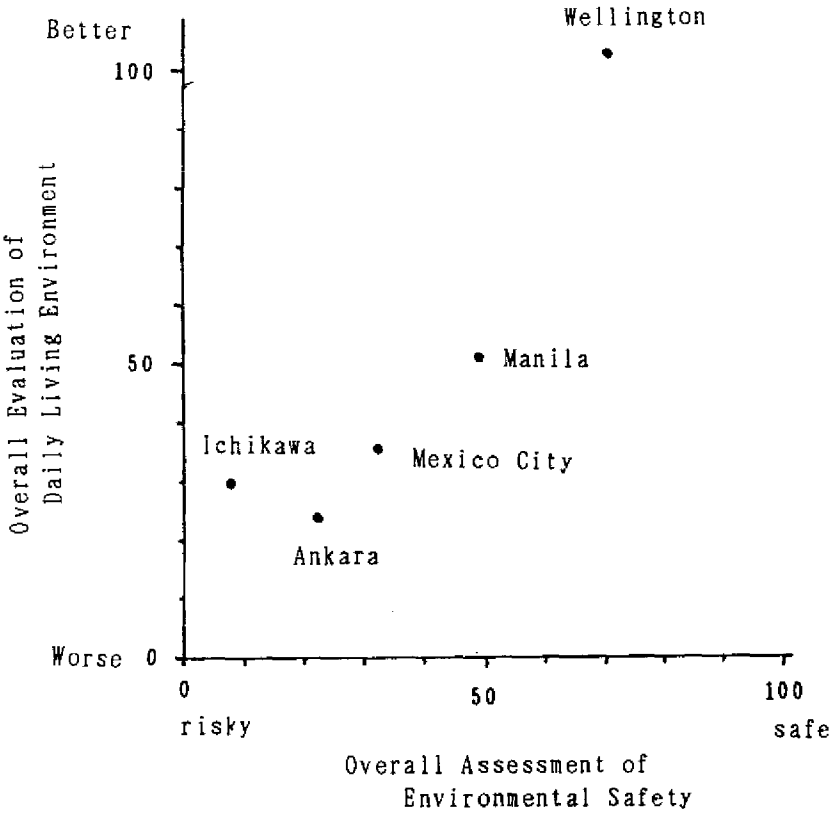

Figure 4-4-1 Correlation between evaluation of living environment and assessment of environmental safety.

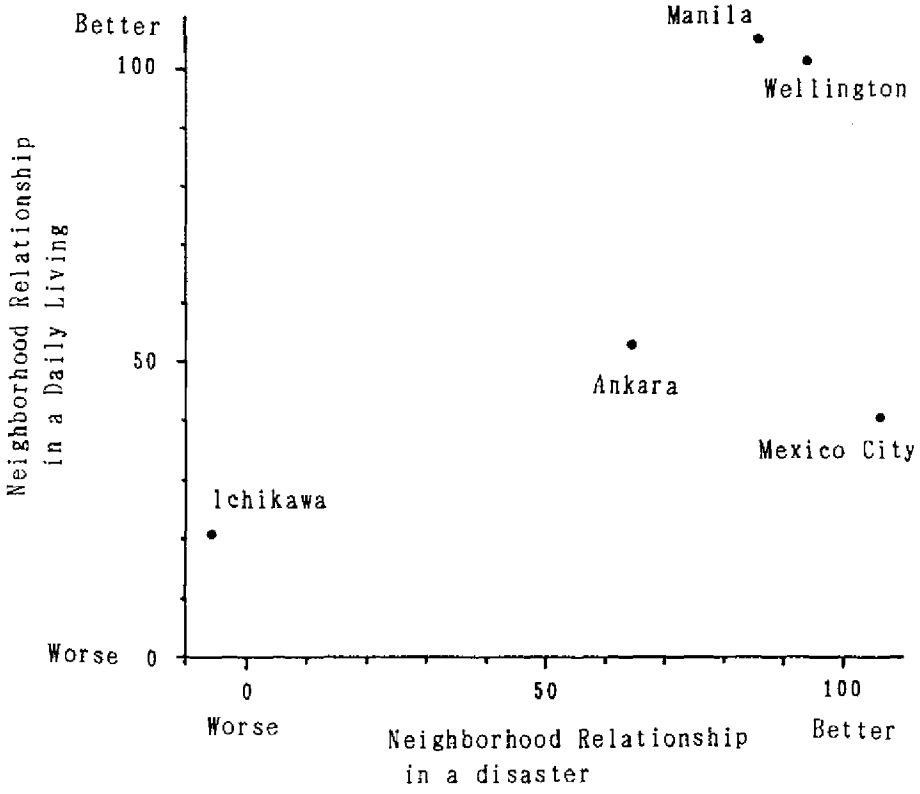

Figure 4-4-2 Correlation of neighborhood relationships between in a disaster and in daily living.

4.5 Concluding Remarks
—— Vulnerability of Cities in Developing Countries

Based on the sense of disasters and awareness for disaster prevention of city dwellers and the assessment of the environment of their own places of living from various aspects, the vulnerability of cities of developing countries can be summarized, from comparative viewpoint with civilized countries, as follows.

(1) Unlike those of civilized regions, the large cities of developing regions still do not comprise an "employment society of major enterprises" where people live and work in different places, but a "self-employed society" of small businesses where they live and work in the same place. Despite the marked inflow of population, the mobility inside cities is lower than in civilized regions. The neighborhood relationship is also close so that the community's capacity to cope with disasters is not inferior to developed regions'. Rather, the human capacity to cope with disasters can be said to be potentially higher than in developed regions.

(2) In developing regions, even in large cities, there are many large households having those vulnerable to disasters such as infants and sick persons. In addition to the vulnerability of buildings, this characteristics of household is likely to increase the human loss. In addition, the urbanized life style in large cities is modernizing so that even in developing regions, the level of self-sufficiency of people's living has markedly declined. Therefore, the possibility of occurrence of living-related functional damage such as the suspension of water, food, electricity, gas and sewage after the disaster become no different from that in civilized regions. The fact that there are many persons vulnerable to disasters requires full consideration when taking post-disaster emergency measures.

(3) The delays in economic development and diffusion of disaster-preventive engineering technology are likely to aggravate the direct damage in large cities of developing regions. In fact, not only experts but ordinary citizens are fully aware of the vulnerability due to the low seismic capacity of buildings and facilities. This seriousness of the direct material damage is likely to increase the human loss, resulting in enormous economic loss which is too large for the area's total production. Its direct economic damage will also greatly affect the national economy.

(4) The greatest damage from disasters is a large amount of building collapse. It requires the strengthening of the seismic capacity of both the existing buildings and new buildings to eliminate this risks. Yet the issue for the developing regions in taking disaster prevention measures is an economic problem. Because of this, development and improvement of the primary technologies for diagnosing buildings' aseismatic capacity and forecasting the damage to buildings becomes the most important issue for the earthquake measures of developing regions. Achievement of measures for not only strengthening buildings' aseismatic capacity but also maximizing the investment effect will require economic and technical assistance by civilized regions. In addition, it is necessary to understand the traditonal technology of constructing houses.

(5) In not only civilized but developing regions, urban areas with poor living environment comprise those highly vulnerable to disasters. The city's vulnerability depends on such urban areas. Therefore, implementation of measures for strengthening the safety of urban areas integrated with the measures for improving their living environment will be effective as a disaster prevention plan. In other words, measures for preventing disasters in urban areas are not special ones but those integrated with environmental improvement and development as the daily living environment.