4.4. Others

4.4.1. Major Public Facilities

Information on seismic damage to major public facilities is very important for the preparation of a seismic disaster mitigation and management plan. In section 4.1, damages for only residential buildings were estimated. In this section, building damages for major public facilities are estimated. The following 9 types of facilities are considered.

(1) Governmental Offices

(2) Police Stations

(3) Traffic Police Stations

(4) Fire Fighting Stations

(5) Hospitals

(6) Primary Schools

(7) Intermediate Schools

(8) High Schools

(9) Higher Education Centers (Universities)

A database was set up with regard to the location, the structure, the year of construction and the number of stories for each facility. Details are explained in Chapter 2, section 2.2.8. The database was used in this analysis. However, not all of the data was homogeneous and was missing for some districts.

(1) Method of Damage Estimation

The method of damage estimation for major public facilities is the same as the estimation made for damages of residential buildings. The number of damaged buildings is calculated by applying damage functions for earthquake motions to each type of building structure.

(2) Damage Estimation

The damage ratio in the southern Districts 16 and 19 is relatively high. This damage distribution is similar to that of residential buildings. The results of the damage analysis show that all public facilities will suffer damages to the same extent as residential buildings.

Public facilities are important for the seismic disaster management plan. Governmental facilities will function as headquarters for the disaster management. Police stations and traffic police function as centres for maintaining public and traffic order. Fire fighting stations function as the main bodies for fire fighting and rescue operations. Hospitals are essential facilities for the treatment of casualties and injuries. Schools will be used as refugee camps. Children who will lead the country in the future study in those schools. Therefore, all public facilities are required to have much more aseismic resistance than the residential buildings.

However, this study shows that public facilities will suffer damages as severe as those of residential buildings. This means the public facilities in Tehran will be difficult to use for disaster management in case of earthquake.

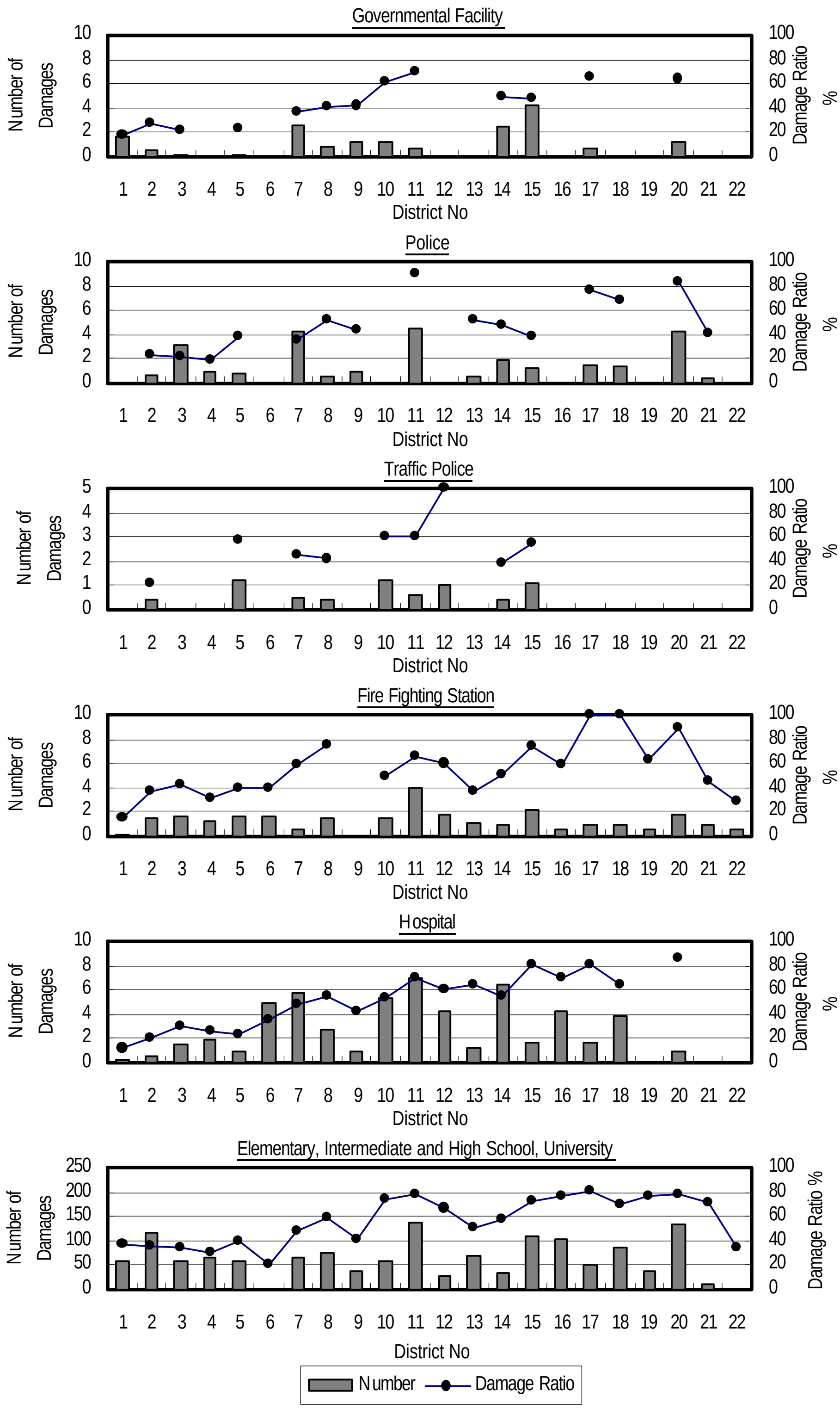
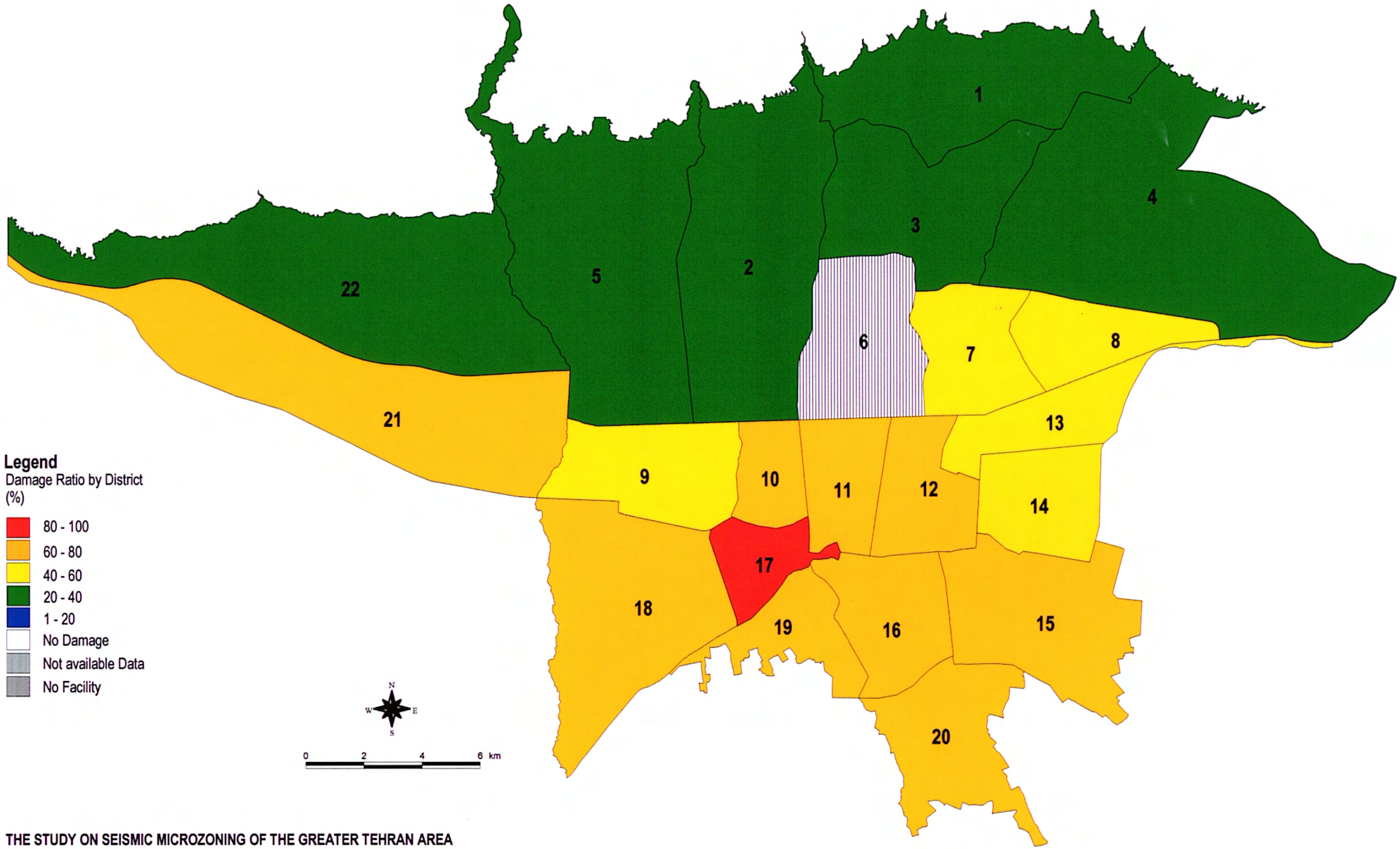


Figure 4.4.1 Damage and Damage Raito of Major Public Facilities by District Ray Fault model

Figure 4.4.2

Damage Ratio of School(Ray Fault model)



THE STUDY ON SEISMIC MICROZONING OF THE GREATER TEHRAN AREA IN THE ISLAMIC REPUBLIC OF IRAN

Centre for Earthquake and Environmental Studies of Tehran (CEST)
Japan International Cooperation Agency (JICA)

4.4.2. Lifeline

Information on seismic damage to lifelines is very important for the preparation of a seismic disaster management plan. In this section, damages for lifelines are estimated. The following 4 types of lifelines are considered.

(1) Water Supply Pipelines

(1) Water supply pipelines

(2) Gas pipelines

(3) Electric power supply cables

(4) Telecommunications cables

(1) Method of damage estimation

The basic concepts for lifeline damage estimation are as follows:

- Except for a few qualitative studies, no quantitative studies on seismic damage for lifelines in Iran were available.
- Structural characteristics of buildings in Iran are different from those in Japan. However, network characteristics, pipeline structures and cable structures are considered similar to those of Japan.
- Although the strength of the pipeline materials is not much different from that of the pipeline materials in Japan, it is considered that the construction quality of the joints always leads to problems.
- Therefore, an analysis method for the damage estimation of water and gas pipelines proposed by Kubo and Katayama (1975), which is widely used in Japan, was applied to the Study. However, it is considered that the damages will be more serious than those estimated.
- Details of the strength of electric power supply and telecommunications cables were not available for the Study. Furthermore, details of the structure and strength of electricity posts, which are significant damage factors for aerial cables, were not available in the Study.
- Therefore, the damages to those cables are estimated using empirical methods based upon the damages that occurred during the 1995 Kobe Earthquake, Japan.
- Consequently, the damages of lifelines estimated here indicate only a relative damage distribution rather than an absolute one.

(2) Estimation for Distribution of Lifeline Facilities in Each Census Zone

Information on the distribution of gas pipelines, electric power supply cables and telecommunications cables were provided based upon each sector’ s ‘ service districts’ . In case of water supply pipelines, only information on the total length of the pipelines was provided.

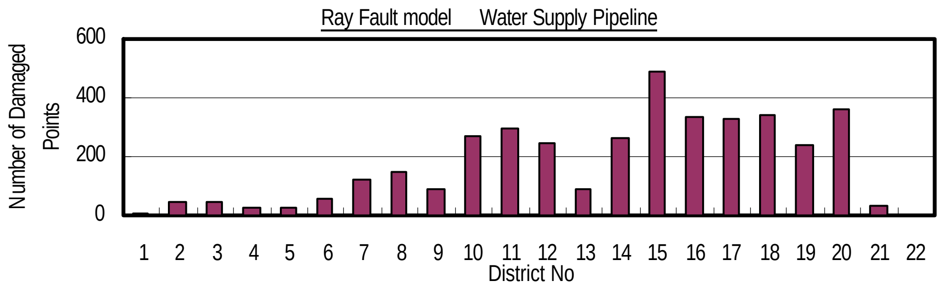
The seismic motion was calculated for each census zone. The result was directly introduced in the calculations for the damages of the lifeline facilities. Therefore, the distribution of pipelines and cables in each census zone was subdivided.

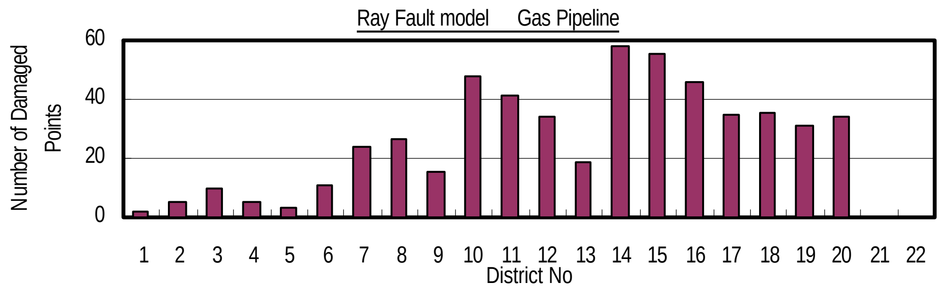
(3) Damage Estimation

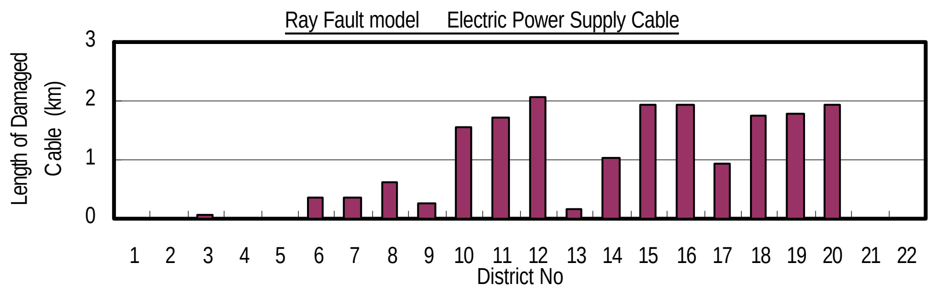
The results of the damage estimations are shown in エラー! 参照元が見つかりません。for the Ray Fault Model. The damage figures are conservative, considering the limitations of the damage estimation procedure.

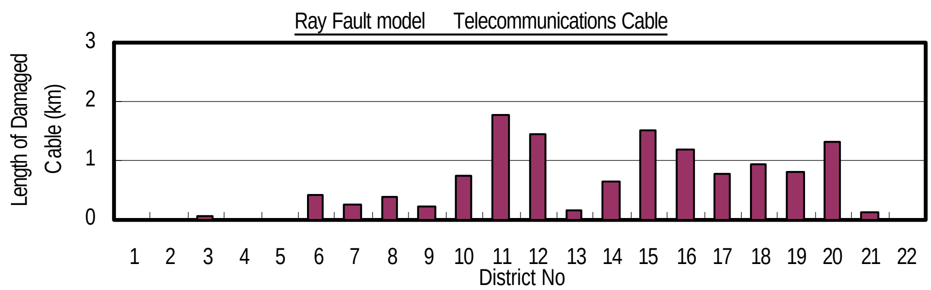
It is clear that, if gas supplies do not shut off immediately, gas leakage will occur everywhere, resulting to explosions and fire outbreaks under the current manual valve shut off manipulation system.

Almost all of the water supply lines will be out of service, and electricity and telecommunications will not be available in the southern part of the city. If independent power generators are not adequately available, the electric power failure may seriously affect the function of other lifelines.









4.4.3. Hazardous Facilities

A possibility of fire outbreaks from facilities where inflammable liquids or gases materials are handled was estimated. The facilities are classified as follows:

(1) Petrol stations

(2) Refuelling stations

(3) Gas refilling workshops

(4) Kerosene distributors

(5) Oil distributors

The concepts of the estimation are as follows:

- The offices of the facilities will suffer damages caused by earthquake motion, and the damage functions for residential buildings were applied to the estimation of damages to office buildings.
- At facilities that are seriously damaged or collapsed, inflammable liquids or gases will leak from the storage tanks.
- The leaking liquids or gases ignite to fire according to the following probability:

  Petrol stations, refuelling stations: 2.55%

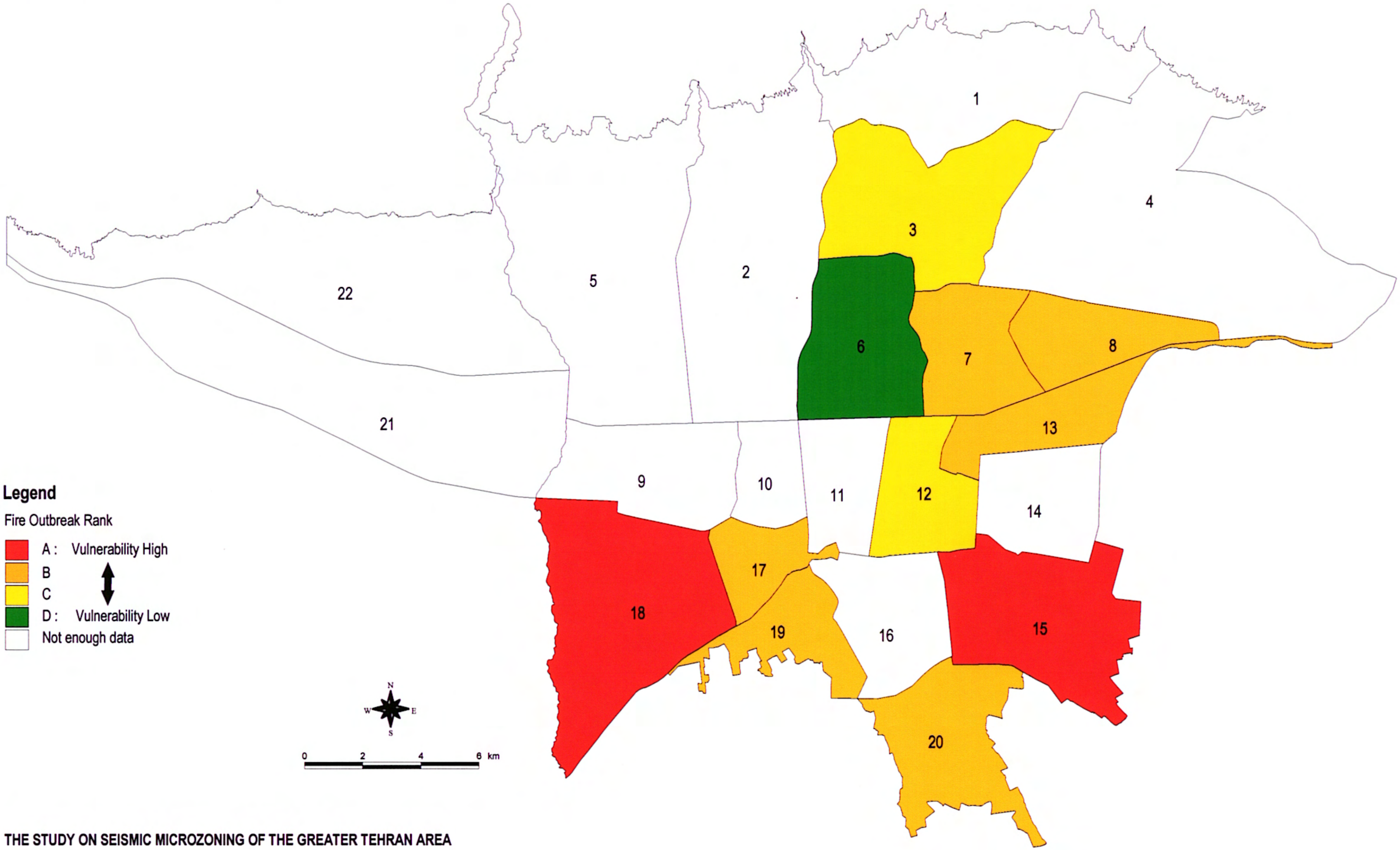
  Others: 3.66%.

  (Kanagawa Prefecture 1986)
- The above values are estimated based on Japanese experience. No case information on the fire occurrence in Iran was available. Consequently, the results show only relative possibility for fire occurrence.
- The number of fire outbreaks is summed up in each district and then expressed as rating of fire hazard.

The distribution for the hazardous facilities is not uniform in the Study area and it is considered that the database was not prepared based upon a uniform criterion. Therefore, fire outbreak was calculated for the municipal districts in which more than 5 hazardous facilities were located within the district. There are only 11 such districts among 22 districts considered in the Study.

Figure 4.4.4

Fire Outbreak Rank from Hazardous Facility(Ray Fault model)



THE STUDY ON SEISMIC MICROZONING OF THE GREATER TEHRAN AREA
IN THE ISLAMIC REPUBLIC OF IRAN
Centre for Earthquake and Environmental Studies of Tehran (CEST)
Japan International Cooperation Agency (JICA)

4.4.4. Liquefaction

(1) General

In this seismic microzoning study, soil strength and seismic motion are to be determined at same levels of quality in the whole Study area. Therefore, using some statistical method is appropriate.

The following information on soil properties and seismic motion was available in the Study:

- Borehole logs with results of Standard Penetration Tests (SPT)
- Statistically compiled physical properties of soil.
- Peak ground acceleration for scenario earthquakes

Considering the above, a combination of the F_L method and the P_L method was used in the Study. This method is commonly used in Japan for practical purposes. The result of the analysis was expressed as a point base, because the quantity of available borehole data was limited. The flowchart of liquefaction analysis in this project is shown in Figure 4.4.4.

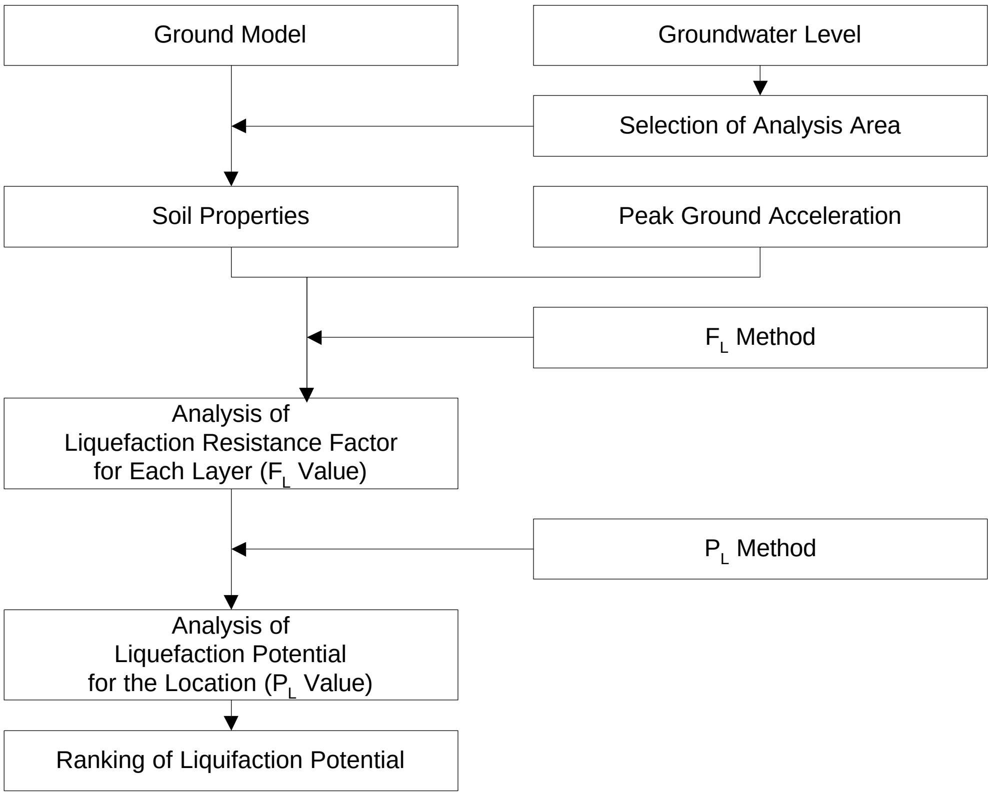


Figure 4.4.4 Flowchart of Liquefaction Analysis

(2) Precondition for the Analysis

Groundwater level and analysed area

The F_L method defines that groundwater level to be accounted as less than 10m from the ground surface. The area with groundwater level less than GL-15m was considered in the Study, considering the fluctuation of the groundwater level. The data on groundwater level was based upon CEST (1998). Details are explained Chapter 2, section 2.2.4, Groundwater. The area selected corresponds to south-eastern part of Tehran, the entire area of Districts 15, 16, 20, the south of Districts 11, 12, 14 and the eastern area of District 19. In the calculations, the groundwater level was modelled as the actual groundwater level minus 5 m. This lead to over-calculated and safe results.

(3) Liquefaction Potential

These results are summarised in Table 4.4.1 and Figure 4.4.4.

Table 4.4.1 Summary of the Liquefaction Analysis

Liquefaction Potential	Criterion	Explanation	No. of Boreholes
Very high	$15<P_L$	Ground improvement is indispensable	0
Relatively high	$5<P_L\leq15$	Ground improvement is required Investigation of important structures is indispensable	1
Relatively low	$0<P_L\leq5$	Investigation of important structures is required	12
Very low	$P_L=0$	No measure required	39

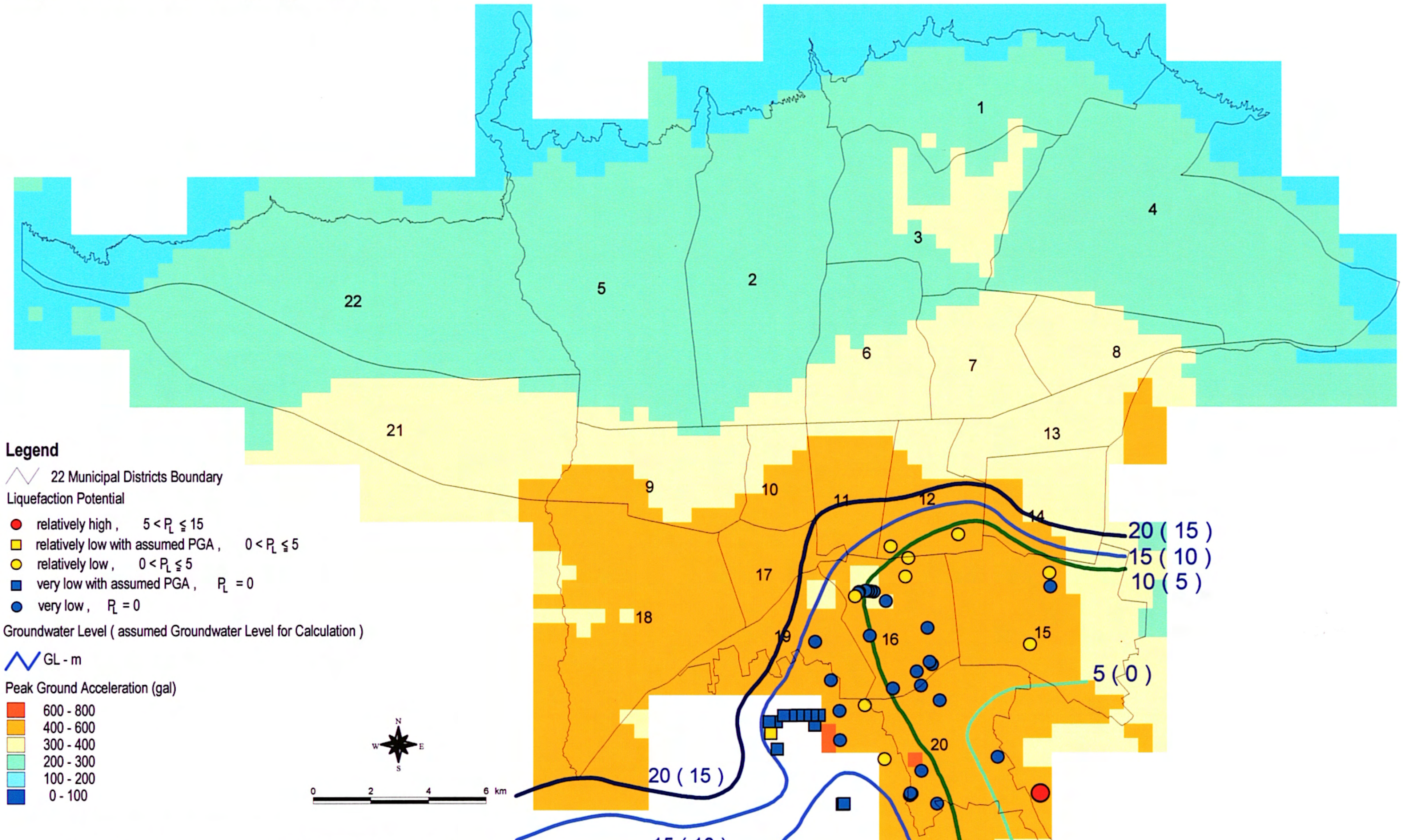
Almost the entire area is rated as having ‘very low’ or ‘relatively low’ liquefaction potential. Stiff cohesive clayey soil is predominantly deposited in the analysed area. Some sand or gravel layers are interbedded the clayey soil.

Only one borehole location was judged as having ‘relatively high’ liquefaction potential. This borehole is located in the eastern area of District 20. The geological circumstances indicate that the distribution of high-potential liquefiable soil in this area is relatively limited.

It is concluded that the risk of liquefaction in the Study Area, with some exceptions, is low. Detailed soil investigation should be carried out to confirm the distribution of such liquefiable soils.

Figure 4.4.6

Liquefaction Potential (Ray Fault model)



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