Chapter 2:

Geographic Database Development

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Since the commencement of the Study, many types of physical, environmental and socio-economic data in the Study area have been collected.

These data were analysed and evaluated as basic information for the Study. In order to analyse the existing conditions of the Study area, the Study Team has developed a GIS database. Based on the output of the GIS database, existing conditions of the study area are explained below.

2.1. Geographic Database Development for Seismic Disaster Management

2.1.1. Introduction

In the past twenty years, Geographic Information System (GIS) database technology has been developed, mainly in the U.S.A. and Canada, as a means to manage and process large volumes of map/spatial data through the full application of computer graphics technology. Because of its most significant capability to handle both graphics and attribute data simultaneously, in recent years, GIS has been used for a wide range of applications in urban/regional management, such as land use planning, environmental or natural resource management, tax assessment and urban utility management. In Japan, after the great Kobe earthquake disaster in 1995, researchers and administrators of local governments are paying much attention on the development of geographic databases for seismic risk assessment of large urban areas. Many large cities have started to construct a multipurpose GIS database, not only for analysis of seismic damage, but also for integrated urban development planning and management based on large-scale topographic maps. These application fields of GIS require relatively complicated data processing of regional/spatial data analysis including overlay, buffer and simulation modelling. For the Study on Seismic Microzoning of the Greater Tehran Area, an integrated geographic database was developed to support the data analysis and planning efforts of the study.

2.1.2. Purpose of the Development of the Geographic Database

In order to carry out The Study on Seismic Microzoning of the Greater Tehran Area, a wide range of urban/regional data must be collected and analysed using the proper methodology to evaluate the spatial vulnerability of seismic disaster in the study area. GIS is considered to be the most practical and appropriate methodology for spatial data compilation, analysis and display. Numerous map data showing regional characteristics can be combined and superimposed by computer and analysed to present spatial distribution of seismic disaster vulnerability. Results of data analysis can be formulated into a series of maps and tables representing significant planning indicators for the development of a seismic disaster mitigation plan.

2.1.3. Design of Geographic Database

Prior to the database development, the Study Team surveyed the existing availability of GIS compatible systems (including hardware, software and manpower for the data digitisation and primary data processing) in Tehran, with a special focus on ARC/INFO compatible systems. Fortunately, technical services for the ARC/INFO GIS is fully available and totally supported by a private company in Tehran. Governmental agencies such as the Ministry of Agriculture, Geological Survey of Iran, Tehran Municipality and Tehran University, etc.,

utilise ARC/INFO GIS. These agencies are using GIS for application in their respective fields or research and educational purposes. Based on the technical background of GIS present in Tehran, the Study Team designed the structure of the geographic database for the Study as shown in Figure 2.1.1

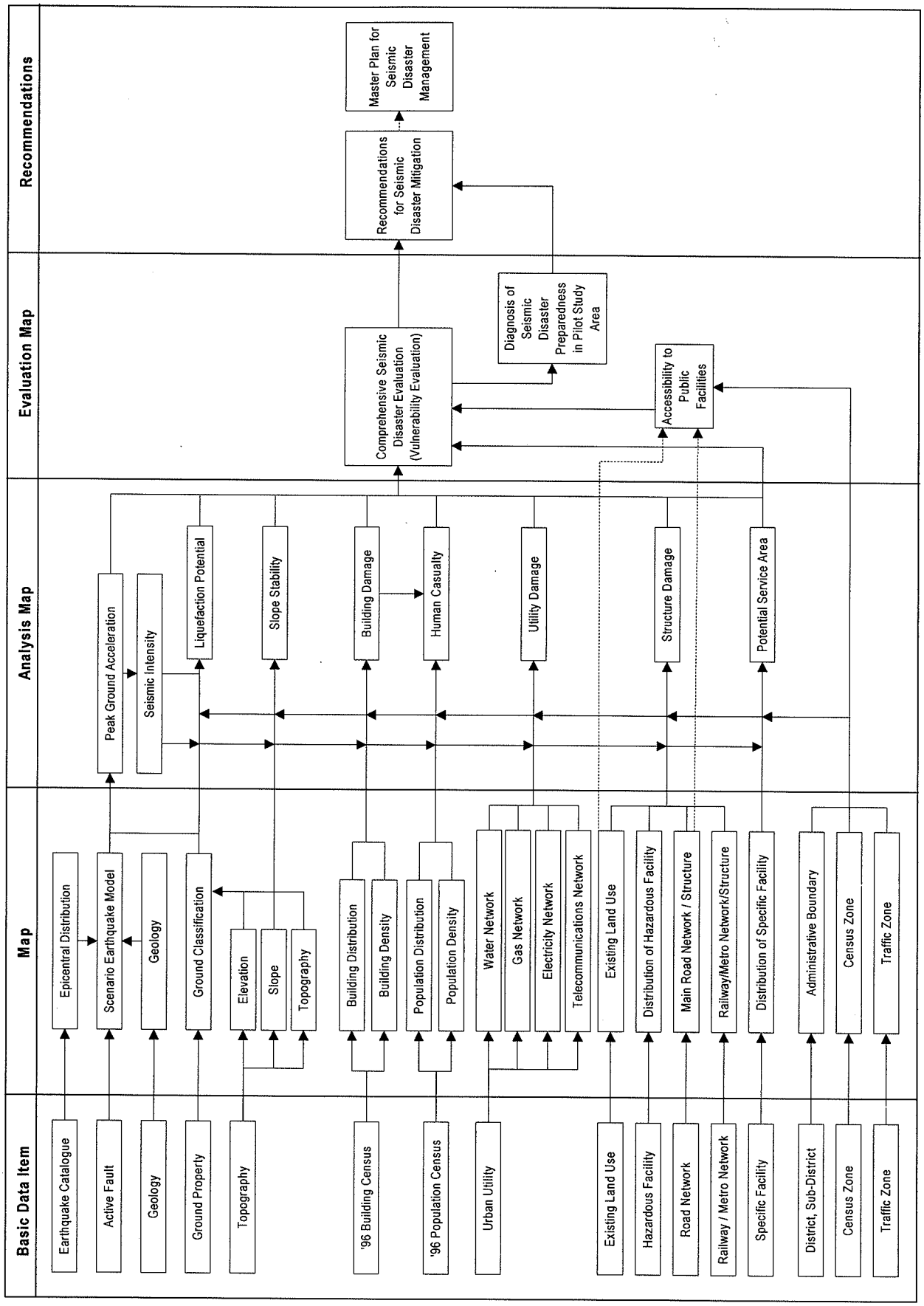


Figure 2.1.1 Structure Of Geographic Database For The Study

2.1.4. Data Collection and Input (Digitisation)

For the development of the geographic database of the Study, the Study Team collected a wide range of basic data covering both natural and socio-economic conditions of the study area. Collected map data were analysed and evaluated based on accuracy, basic scale, date of compilation, method of survey and source agency. In order to develop a geographic database for the study area within the limited time of the Study and to efficiently support data analysis and planning efforts, the Study Team carefully discussed the base map scale with the concerned agencies and ultimately determined a base map scale of 1:25,000 would be the most appropriate for the development of the Study's geographic database. After the design of the database and necessary processing were undertaken, one complete map sheet was generated so as to easily understand the whole study area. Data input/digitisation was subcontracted using local GIS functions and experts to minimise and execute the necessary data conversion from map-form to digital data within a short period. Existing digital data files were also incorporated into the database. Source agencies of collected data are listed in Table 2.1.1. Data input for this Study include the following items:

- Topographic map
- Census zone boundary map
- District and sub-district boundary map
- Traffic zone map of the Tehran Comprehensive Transportation and Traffic Study, 1996
- Road network map
- Location and attributes (structural type/age/number of stories) of critical buildings such as schools, hospitals, police stations, religious buildings, fire stations, city halls and government buildings
- Population map by census zone (1996)
- Residential buildings by census zone, structural type (9 categories), age (5 categories), and number of stories (5 categories) (1996)
- Other Buildings by census zone (same categories as above, 1996)
- Geological map
- Groundwater level
- Location of large-scale bridges, flyovers, open-cut and embankments
- Metro/railway network (same structure as above)
- Main water pipeline network
- Main gas pipeline network
- Main electricity line network
- Telecommunication network
- Location of hazardous material

Table 2.1.1 Collected Data for Database Set-Up (1)

Subject	Contents	Related agency / Source	Medium	Reference, Remarks
Topography	Topographical Characteristics	Feghhi, K.H. (1999)	Paper	Feghhi, K.H. (1999): Affection of active faults on groundwater table in Tehran region, Proceedings of the third international conference on seismology and earthquake engineering, Vol.1 pp.127-137.
Topography	Topographical map	1:25,000 scale	Paper	Tehran GIS Center(1995)
Topography	Topographical map	1:10,000 scale	Paper	Iran National Cartgraphic Centre(1967)
Topography	Slope classification map		Computer Data file	Beautification Organization, Tehran Municipality(1995)
Geology	Geologic map	Ghassemi (1999)	Drawing, explanation documents	Mohammad R. Ghassemi(1999), Report on the Geological map of Tehran region, Tectonic Group, Geological Survey of Iran.
		Rezaien(1998)	Paper	Rezaeian, M. (1998): Interaction of faults on water table changes in Tehran Plain, A thesis submitted in partial fulfilment of requirement for degrees of master of science, Shahid Beheshti University.
		Engalenc(1968)	Paper	Engalenc, M. (1963): Contribution a la geologie, geomorphologie, hydrogeologie de la region de Teheran (Iran), Centre d'estudes et de recherches hydrogeologiques, (in French).
		Rieben (1966)	Paper	Rieben (1966): Geological observations on alluvial deposits in northern Iran, Geological Survey of Iran, Report No. 9.
		Rieben (1955)	Paper	Rieben, H. (1955): The geology of Tehran Plain, American journal of science, Vol.253, pp.617-639.
Geology	Fault map	CEST(1998)	Autocad file	CEST (1998): Seismotectonic and earthquake fault hazard study for the proper location of highrize buildings in Tehran, Data processing and urban planning office, Municipality of Tehran, (in Farsi).
		CEST(1998)	1:50,000 scale map	CEST (1998): Seismotectonic and earthquake fault hazard study for the proper location of highrize buildings in Tehran, Data processing and urban planning office, Municipality of Tehran, (in Farsi).
		Berberian et. al.(1983)	Paper	Berberian,M. M., Ghoreishi,B., Arajang R awesh, A. Mohajer Ashjai, (1983): Seismotectonic and earthquake fault hazard investigations in the Tehran region, Geological Survey of Iran, Report No. 56, (in Farsi) .
Geology	Existing borehole log	Geotechnical and Strength of Materials Study Center, Tehran Minuciparity	Hardcopy of logs	
		Soil Engineering Service Consulting	Hardcopy of logs	
		Daryakhak Consulting Engineers	Hardcopy of logs	

Table 2.1.1 Collected Data for Database Set-Up (2)

Groundwater	Groundwater table map	CEST(1998)	Autocad file	CEST(1998): Study of the half comprehensive environmental plan of Greater Tehran in a 1:25,000 scale, water resources, geology, meteorology, Technical development office, Municipality of Tehran, (in Farsi).
Earthquake	Earthquake activity	Berberian, M. and Yeats, R. S. (1999)	Paper	Berberian, M. and Yeats, R. S. (1999): Patterns of historical rupture in the Iranian Plateau, Bulletin of the seismological society of America, Vol. 89, No.1, pp120-139.
Earthquake	List of earthquake and those waveforms	Institute of Geophysics, Tehran University	Computer Data file	Shahran Station
Earthquake	List of earthquake	Moinfar, A.A., Mahdavian, A. and Maleky, E. (1994)	Book	Moinfar, A.A., Mahdavian, A. and Maleky, E. (1994): Historical and instrumental data collection of Iran, Iranian cultural fairs institute.
Earthquake	List of historical earthquake and those damage records	Ambraseys and Melville(1982)	Paper	Ambraseys, N. N. and Melville, C. P. (1982): A History of Persian earthquake, Cambridge University Press.
Land Use	Land use map	Tehran GIS Center (1995)	ArcView File	Several layers are selected for the study. Scale of the map is 1:25,000
Census	Census Zone Maps	Statistics Center of Iran (1996)	Paper	Total of 422 sheets (A0 size) collected and digitised by study team.
Population	Population data of 1996 Census	Statistics Center of Iran (1996)	Computer Data file	Detail population data by Census block (Smaller than census zone). Aggregated into census zone by study team.
Building	Building data of 1996 Census	Statistics Center of Iran (1996)	Computer Data file	Data consist of 1)Structure, 2)Building Age and 3)Number of Storey
Urban facility	Fire fighting stations data	Fire Fighting Department, Tehran Municipality (1999)	Paper	Data consist of 1)Structure, 2)Building Age, 3) Size of building and 4)Number of Storey
	Health and Medical Care facilities data	Ministry of Health (1999)	Paper or Computer Data file	Data consist of 1)Name, 2)Address, 3)Function of building, 4)Facility site area and 5)building information
	Police and Traffic Police Facilities data	20 Municipal Districts	Paper or Computer Data file	Data consist of 1)Name, 2)Address, 3)Facility site area and 4)building information
	Governmental facilities data	20 Municipal Districts	Paper or Computer Data file	Data consist of 1)Name, 2)Address, 3)Facility site area and 4)building information
	Educational facilities data	20 Municipal Districts	Paper or Computer Data file	Data consist of 1)Name, 2)Address, 3)Facility site area and 4)building information
	Religious facilities data	20 Municipal Districts	Paper or Computer Data file	Data consist of 1)Name, 2)Address, 3)Facility site area and 4)building information
	Parks and Public open spaces	20 Municipal Districts	Paper or Computer Data file	Data consist of 1)Name, 2)Address, 3)Facility site area and 4)building information
Hazardous facility	Hazardous facilities data	Fire Fighting Department, Tehran Municipality (1999)	Paper	Data consist of 1)Name, 2)Address, 3)Type of facility, 4)Storage capacity and 5)Type of stored material

Table 2.1.1 Collected Data for Database Set-Up (3)

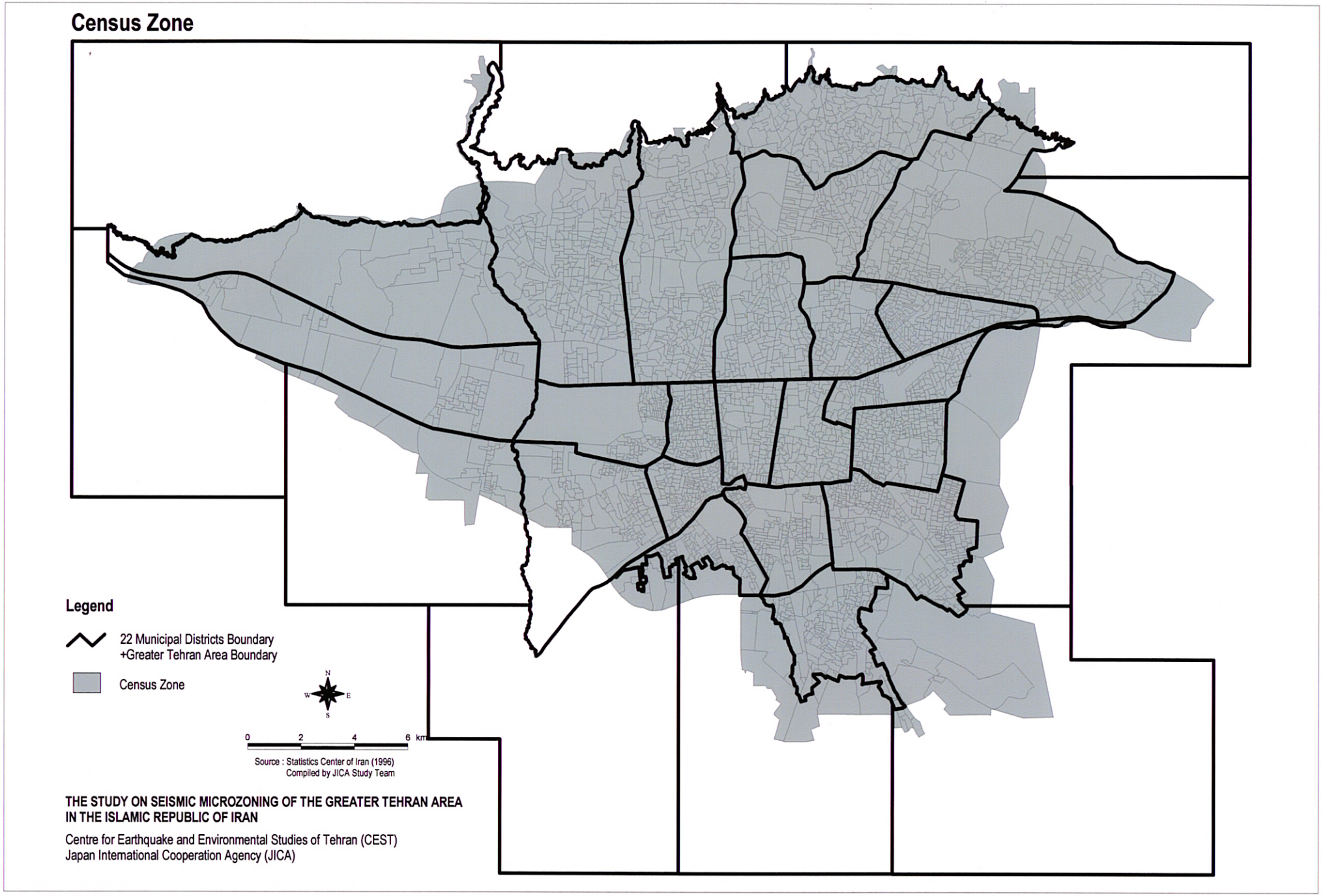
Transportation	Traffic Zone Map of TCTTS	Tehran Comprehensive Transportation & Traffic Study (1996)	Autocad file	560 Traffic Zones within the 22 municipal districts
	Road network data	Tehran Comprehensive Transportation & Traffic Study (1996)	Autocad file	Tehran major road network file
	Road length data	Tehran GIS Center (1995)	Autocad file	Center line data by each width of road
	Bridge data	TETCO, Tehran Municipality (1999)	Computer Data file	Data consist of 1)Name, 2)Location and 3)Detail structure of bridge
	Tunnel section data	TETCO, Tehran Municipality (1999)	Computer Data file	Only one tunnel exists in study area. Data consist of 1)Name, 2)Location, 3)Size of section, 4)Material, and 5)Construction Method
Lifeline	Water supply data	Tehran Province Water and Sewage Co. (1999)	Autocad file(Network Map) and Paper(General Inf.)	General information documents and Network map data
	Natural Gas supply data	National Iranian Gas Co. (1999)	Paper(Network Map and Length of Network)	Local distribution network length by type of pipes and Network map
	Electric Power supply data	Power Generation & Transmission Co. (1999)	Autocad file(Network Map) and Paper(Length of Network)	Local distribution network length by type of pipes and Network map data
	Telecommunications data	Telecommunication Co. of Iran (1999)	Autocad file(Network Map) and Paper(Length of Network)	Local distribution network length by type of pipes and Network map data

2.1.5. Data Analysis Unit

In urban/regional planning, the data analysis unit usually employed is that of administratively delineated city sub-districts, or some smaller unit. In Tehran, however, despite the effort to locate data for these administrative units, the Study Team found only concrete and detailed maps for Tehran's 22 district boundaries.

According to the Statistics Center of Iran (SCI), a census survey is conducted once every 10 years and a supplemental survey once every 5 years. In Tehran, a total of 34,805 census blocks are identified and these blocks are aggregated into 3,173 census zones (Figure 2.1.2). Statistical data on population and buildings were accumulated based on these census units. These data were provided to the Study Team in DBF file format by SCI. The census zone boundary was drawn on the traditional Mylar base map (scale 1:2,000), which consisted of 422 sheets. In this Study, the census zone boundary is used as the base unit for the spatial data analysis.

Figure 2.1.2


Census Zone
Legend
22 Municipal Districts Boundary
+Greater Tehran Area Boundary
Census Zone
N
W
E
S
0
2
4
6 km
Source : Statistics Center of Iran (1996)
Compiled by JICA Study Team
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)

2.1.6. Data Analysis

Based on the geographic database, spatial characteristics of natural and social conditions of the study area were analysed. The data analysis process consists of three stages: the primary, secondary and tertiary. During the primary data analysis stage, a simple overlay analysis was conducted to show the existing conditions of the study area. For instance, the census zone, district boundary and related population data were combined and displayed together as a population map.

During the secondary data analysis stage, primarily processed data items were combined and superimposed on each other. Seismic disaster potential of the study area was analysed and mapped.

During the tertiary data analysis stage, detailed seismic damages were assessed based on the analysis results of previous stages. All outputs generated by these data processing were mapped and related tables were compiled.

Existing natural and social conditions of the study area, based on the primary data analysis, are described in Chapter 2, section.2.2. Results of the secondary and the tertiary data analysis are described in Chapter 4.

2.1.7. Comprehensive Evaluation of Vulnerability

Overall seismic disaster vulnerability of the study area was evaluated by physical and social indicators. District seismic vulnerability was examined and mapped in radar chart format.

2.1.8. Execution of Pilot Study

A pilot study was conducted to learn, in detail, the level of seismic disaster preparedness in the urban community. A property-based building survey was conducted, and a detailed database was developed. A diagnosis of seismic disaster preparedness in the pilot study area was compiled, and issues for seismic disaster mitigation were stated.

2.1.9. Recommendations for Seismic Disaster Mitigation

Recommendations for seismic disaster mitigation were described from institutional, urban planning and architectural points of view.