CHAPTER 3

ELEMENTS AT RISK

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3. ELEMENTS AT RISK

3.1. Development of the Industry in Istanbul

Istanbul is believed to be one of the oldest continuously occupied metropolises in the world. In recent decades it has experienced unprecedented growth. Between years 1950 and 2000 the population has increased at least nine-fold from about one million to nine million. Today, Istanbul houses one-eighth of the total population and one half of the industrial potential of Turkey. According to Tümertekin (1997) 40% of the industrial facilities in Turkey are located in the city and 30% of the population working in the industry live in Istanbul.

Istanbul acted as the capital of three empires, Roman, Byzantine and Ottoman. During all these years all urban functions and activities were clustered in distinct parts of the city; the Old City, Galata and Kadıköy. The old city, also called as the historical peninsula, was where most of the population lived and where the administrative and political activities took place. The commercial life of the city was led in Galata and later on in Beyoğlu, across the Golden Horn. Obviously the density and intensity of these activities grew with time. It was not until the second half of the 19th century, however, that the city started to grow towards north. Along the Bosphorus there were only small settlements and summer resorts. With the start of industrialization, small-scale facilities started to appear. Within time industrial facilities started to cluster along the shores of Haliç (Golden Horn), which eventually became the first industrial area in Istanbul. Figure 3.1.1 for an illustration of the growth of the city starting from the Byzantine era and extending until 1994.

The industry in Istanbul started to grow considerably in the 1950's. Although industrial areas were marked and planned in the land-use plans prepared for the city, mainly lack of control and authority hindered those plans to be fully followed. Today there is a variety of industrial activities and services in Istanbul in terms of both type and quality. In the historical peninsula there are still a lot of small scale facilities in old and very poorly maintained buildings, often relying on hand production. There are industrial areas which have been surrounded by residential buildings with the growth of Istanbul in time and thus were left within city limits, such as Topkapı, Şişli, Ayazağa, Bomonti, Güneşli, Maltepe and Ümraniye (Figure 3.1.3). These areas house light industry with generally newer and higher quality facilities (Tümertekin, 1997). On the Asian side the majority of industrial facilities are located in Maltepe. The new investments are mainly in areas towards İzmit starting in Tuzla to the east of Maltepe. They are positioned along the two highways connecting İstanbul with Ankara. On the European side the industry is generally to the north of the E-5 highway. Topkapı, Zeytinburnu, Bayrampaşa, Rami, Halkalı, Sefaköy, Güngören, Avcılar (Figure 3.1.3) are examples which have grown as industrial areas within the last 30 years. The industrial areas and their relations with other functions in Istanbul have been presented in Figure 3.1.2. The figure is a compilation from İstanbul Nazım Planı (1995).

Recently localities in neighbour cities have become areas, where industrial investments from Istanbul have been focused, such as Çorlu, Çerkezköy and Lüleburgaz on the European side and Gebze on the Asian side. (Figure 3.1.4)

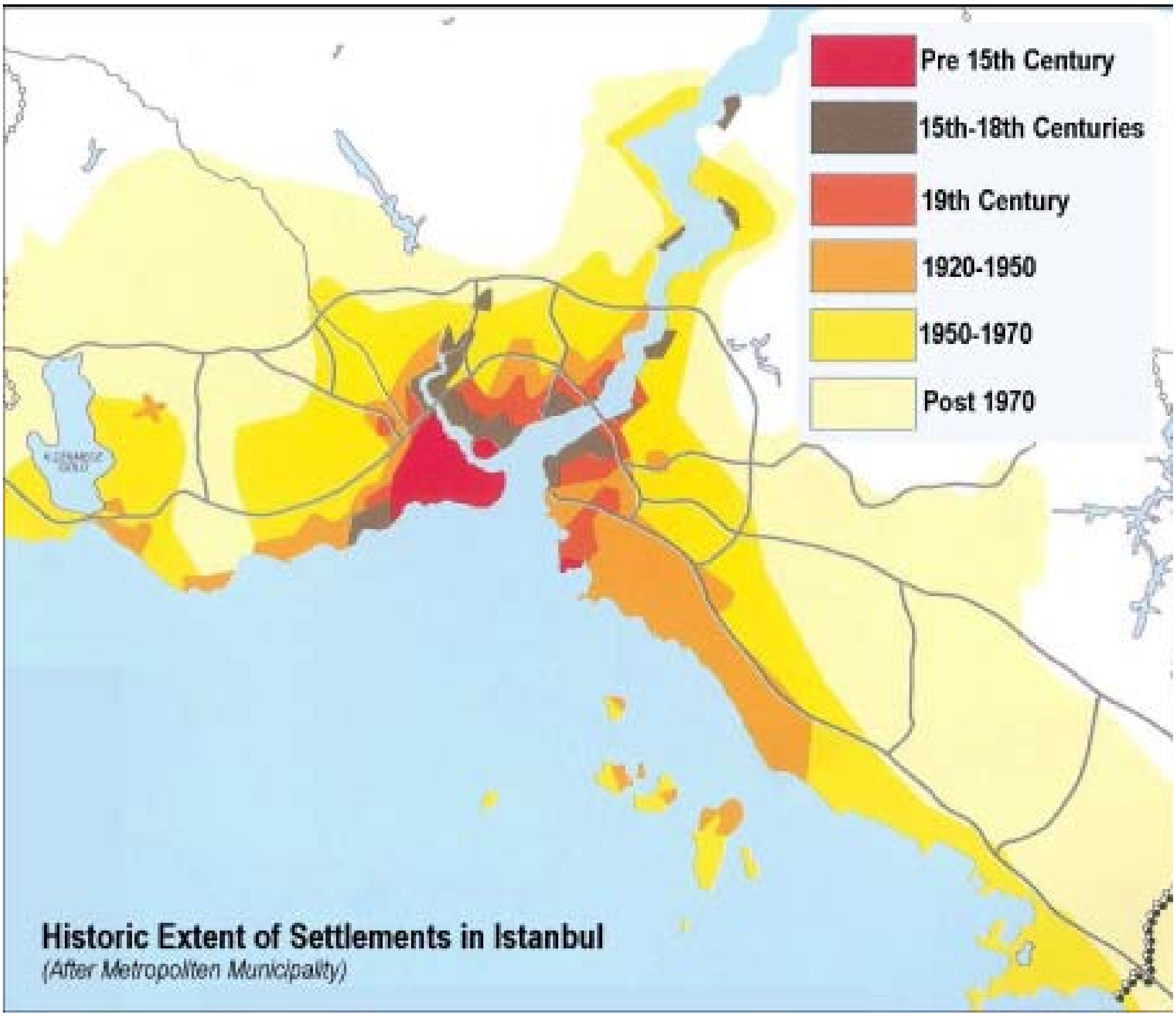


Figure 3.1.1. Historic growth of the city of Istanbul

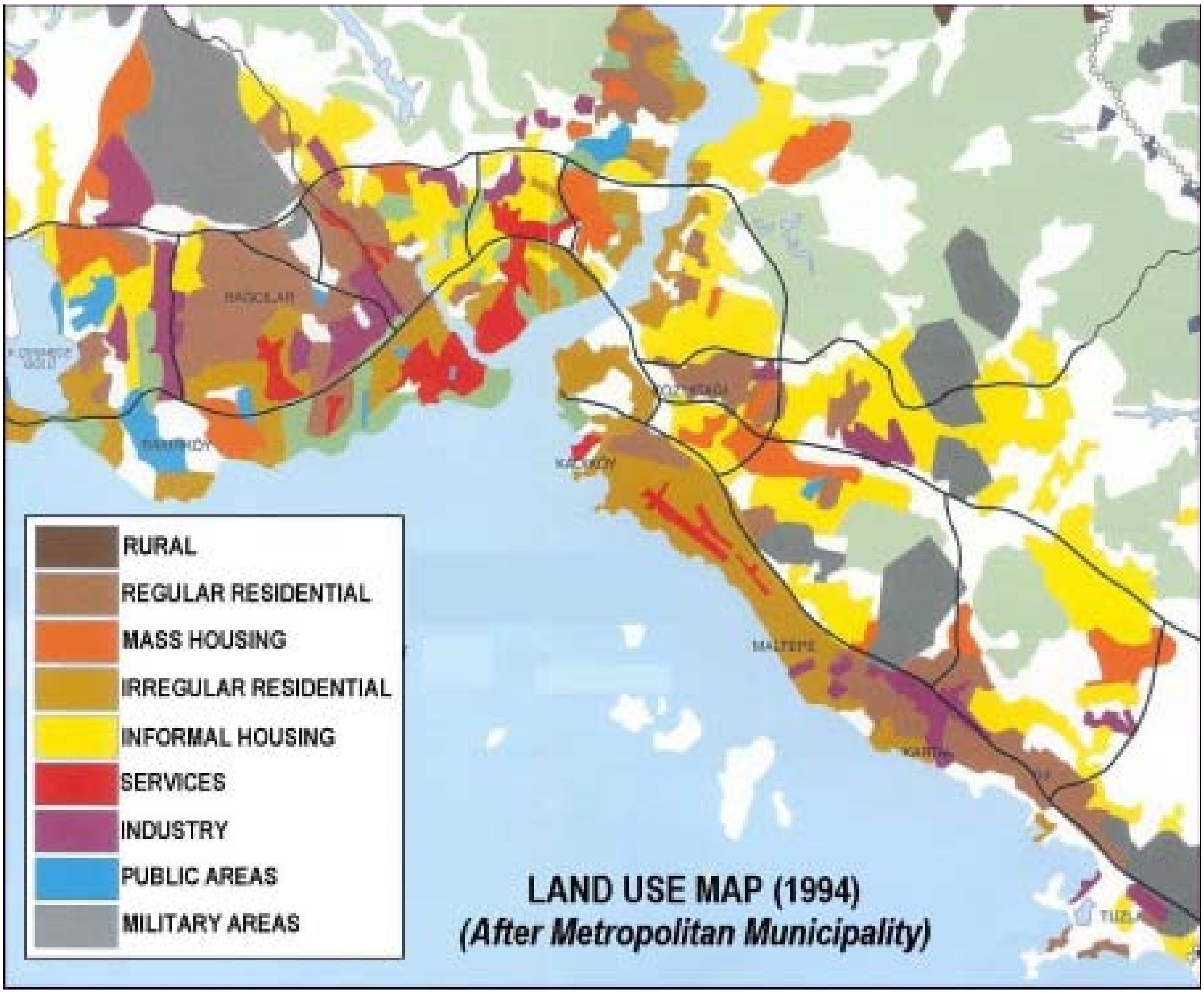


Figure 3.1.2. Land use map of Istanbul in 1994

Figure 3.1.3. Location map

Figure 3.1.4. Location map including neighboring provinces components of industrial facilities Earthquake resistant design considerations.

Industrial facilities consist of buildings, their contents, pipelines, storage areas and/or tanks, silos, chimneys, cranes, conveyor systems, etc. From the design engineer's point of view, an industrial facility has three major components; building structures (office buildings, production buildings, storage areas), non-building structures (cranes, tanks, silos, chimneys, towers etc.) and nonstructural elements (architectural, mechanical, electrical).

3.1.1. Buildings

Buildings in an industrial facility can be of reinforced concrete, of steel or they can be prefabricated. Prefabricated structures exist widely in the industrial facility stock in Turkey. All building constructions should comply with the Turkish Earthquake Resistant Design Code. Many industrial facilities are designed by international teams, thus their design may conforms with international codes (such as UBC, EuroCode, IBC2000) as well. For buildings to be retrofitted for improved earthquake performance there does not exist any official code in Turkey. In isolated instances FEMA273 or FEMA356-Prestandarts have been used in such cases.

3.1.2. Non-Building Structures

Non-building structures are tanks, vessels, pressurized spheres, silos, chimneys, stacks, trussed towers, cooling towers, inverted pendulum type structures, signs and billboards, bins and hoppers and storage racks supported at grade.

Elevated liquid tanks, pressurized tanks, bunkers, silos, chimneys, cooling towers, inverted pendulum type structures and storage racks are classified as non-building structures by the Turkish earthquake resistant design code, the dynamic analysis of which can be performed based on the guidelines presented in the code. Each type of these structures has an assigned ductility factor. Live load participation factors are not applicable to the analysis of these structures and with the exception of snow and crane loads, all types of loads will be considered in full in the analysis.

Comprehensive guidelines do not exist specifically for the earthquake retrofit of these non-building structures.

3.1.3. Nonstructural Elements

Certain nonstructural elements such as exterior cladding, partition walls etc. and mechanical and electrical components such as heating and air conditioning systems, elevators etc., are considered architectural components

In United States, the most widely used design requirements for non-structural components have been the Uniform Building Code. UBC 1997 has been replaced with the International Building Code 2000. The design forces defined in UBC 1997 and IBC 2000 are to be used with strength design. The IBC 2000 is based on NEHRP 1997 recommendations (Bachmann and Daniel, 1998). The earlier version of the UBC was dated 1994, where the design forces were to be used with working stress design. The differences between UBC 1994 and UBC 1997 were that UBC 1997 introduced site soil type, and near source factors, that the design forces vary linearly with height of the building (changing between 1 and 4 depending on the relative location of the element along the height of the building) and that the component amplification factor was increased from 2 in UBC 1994 to 2.5 in UBC 1997. Generally the design force equation considers seismic site coefficient, component amplification factor changing between 1 (rigid components) and 2.5 (flexible components), component importance factor varying between 1 and 1.5, component force reduction factor and relative location factor which is explained above. IBC 2000 is essentially based on NEHRP 1997 recommendations. The design force equation in IBC 2000 has basically the same form of UBC 1997. However it uses the short period spectral acceleration taken from the contour maps and adjusted for local site conditions.

Researchers have made several critiques of the new provisions. Singh and Moreshi (1998) noted that the assumption that roof acceleration is three times the ground acceleration irrespective of their periods leads to highly conservative estimates of acceleration coefficients for most buildings. They also note that NEHRP1997 provisions do not account for the dynamics of the non-structural element, which may lead to resonance effects and find that the methods may underestimate the response of components with natural frequencies higher than the frequency of the building. These two points have also been stressed by Kehoe and Freeman (1998) and by Gurbuz et al (1998).

Nonstructural elements are covered in section 6.11 of the Turkish Earthquake Resistant Design Code (1998). The code distinguishes between the treatment of the architectural elements and the mechanical and electrical components. The architectural components such as exterior cladding, partition walls etc are designed for earthquake forces found by the multiplication of the weight of the element with the spectral acceleration factor calculated by multiplying the seismic zone coefficient with the importance of the building. For the mechanical and electrical components the design forces are found by multiplying the weight of the component, effective ground acceleration parameter, building importance factor and the height factor which varies between 1 and 2. The code states that the equipment will be considered in the overall dynamic analysis of the building if its weight exceeds 0.2 x the weight of the floor it is installed in. Fire suppression systems, emergency power equipment and heating systems, as well as all equipment connected to infill walls, are to be designed for two times the forces found by the procedure explained above. For industrial structures, if the floor acceleration spectra are available, they can be used instead of the procedure described above. The Turkish Earthquake Design Code does not take into account local soil factor, near-fault effects, the ductility of the element, and component dynamic amplification in the design of nonstructural components and their connection.

FEMA 273 and the newer FEMA 356 Pre-standard, NEHRP Guidelines for Seismic Rehabilitation of Existing Buildings addresses nonstructural components as well. The document provides a list of nonstructural components to be rehabilitated to achieve a life safety or immediate occupancy performance level for three zones seismicity (high, moderate and low) and defines the analysis method to achieve rehabilitation (force, displacement or prescriptive).

So far the codes have not been very clear in the seismic design of elements, components and anchoring. The practice was to design the anchoring only to the rules given in the codes and assume that the component or element itself will sustain the strong shaking. FEMA 302 (1997) addresses to the seismic design of the mechanical and electrical equipment. The important issues are described below:

1. If the supported weight of the non-structural systems and components with flexible dynamic characteristics exceeds 25% of the weight of the building, the building will

be designed considering the interaction effects between the building and the supported items. The friction between the equipment and the floor will not be considered in the seismic design.

2. The total seismic force to be applied at the center of gravity of the equipment is to be determined as a function of the operational weight of the equipment, effective ground acceleration, amplification factor, aspect ratio and height of the equipment and the importance factor.

3.2. Inventory of Industrial Facilities

Industrial facilities in Istanbul can be classified into two groups: Small to medium sized facilities and large scale facilities. The inventory of small to medium size facilities is based on TurkTelekom and Istanbul Municipality data. The inventory of large scale facilities relies on data from local municipalities, special reconnaissance surveys and questionnaires covered in Chapter 4.

3.2.1. Small to Medium Size Industrial Facilities

3.2.1.1. Turk Telekom Data

The maps of Turkish Telecommunication Association (Turk Telekom) have been an invaluable source of information for the compilation of data regarding various facility stocks in Istanbul. The maps (usually of 1/1000 scale) were on raster image format for the European side and on paper format for the Asian side of Istanbul. For some dense areas 1/500 maps were also available. All the maps have been visually screened by a group of students and engineers and data have been compiled for small to medium size industrial facilities. The categorized sectors are given in the following table.

Table 3.2.1. Description of Industrial Sectors.

SECTOR No.	DESCRIPTION
Sector 1	Mining, Construction, Ceramics, Glass
Sector 2	Commercial Facilities, Food and Beverage
Sector 3	Textile, Leather
Sector 4	Wood products and furniture, Agriculture
Sector 5	Chemical and Petroleum Products
Sector 6	Iron- steel and the other metals
Sector 7	Machinery and automotive
Sector 8	Transportation and telecommunication

A total of 1060 maps for the European side and 1573 maps for the Asian side of the city of Istanbul have been screened. The resolution of the maps allowed for a reliable data compilation. Data entry has been accomplished in a spreadsheet format suitable for the generation of thematic maps. The resulting database contains fields from where a variety of attributes (such as name, total area covered, type and number of buildings) about each facility are easily attainable.

These data have been transferred to GIS in order to be associated with grids of 600m by 900m, generated in MapInfo format, corresponding to the original Turk Telekom maps. Afterwards these facilities have been overlaid on the site dependent intensity map (Figure 3.2.1 through Figure 3.2.8) .Figure 3.2.9 illustrates the pie chart distribution of the eight sector groups for each cell, the size of the pie chart indicating the total number of the industrial facilities in the cell. Table 3.2.2 gives the distribution of the sectors regarding the districts of Istanbul.

Table 3.2.2. District-based distribution of small to medium size industrial facilities.

DISTRICT	Sect.1	Sect.2	Sect.3	Sect.4	Sect.5	Sect.6	Sect.7	Sect.8
Avcilar	77	58	94	44	47	26	26	3
Bagcilar	156	118	137	55	51	44	44	25
Bahcelievler	62	53	112	31	43	39	31	28
Bakirkoy	67	25	16	17	17	11	11	1
Bayrampasa	18	3	8	1	2	3	3	0
Besiktas	31	7	2	0	7	1	1	3
Beykoz	31	35	8	14	10	5	3	0
Beyoglu	115	26	10	9	16	18	11	11
Eminonu	1	0	5	0	0	1	1	1
Esenler	18	11	9	2	1	4	4	3
Eyup	22	25	15	3	12	12	9	0
Fatih	1	5	4	2	4	1	0	1
Gaziosmanpasa	102	182	24	21	75	26	17	0
Gungoren	95	2	27	2	8	7	3	0
Kadikoy	23	53	10	21	10	6	23	2
Kagithane	38	18	21	8	36	17	21	1
Kartal	50	117	49	47	68	62	101	3
Kucukcekmece	122	66	87	47	53	44	52	10
Maltepe	18	41	7	17	23	14	27	2
Pendik	32	53	10	16	53	33	39	6
Sariyer	21	32	3	2	10	3	13	3
Sisli	104	39	30	15	44	8	24	10
Sultanbeyli	5	19	4	10	3	4	3	2
Tuzla	18	22	20	8	23	9	17	11
Umraniye	37	89	24	27	38	55	42	3
Uskudar	22	66	11	22	9	3	11	1
Zeytinburnu	10	7	13	2	7	3	6	2

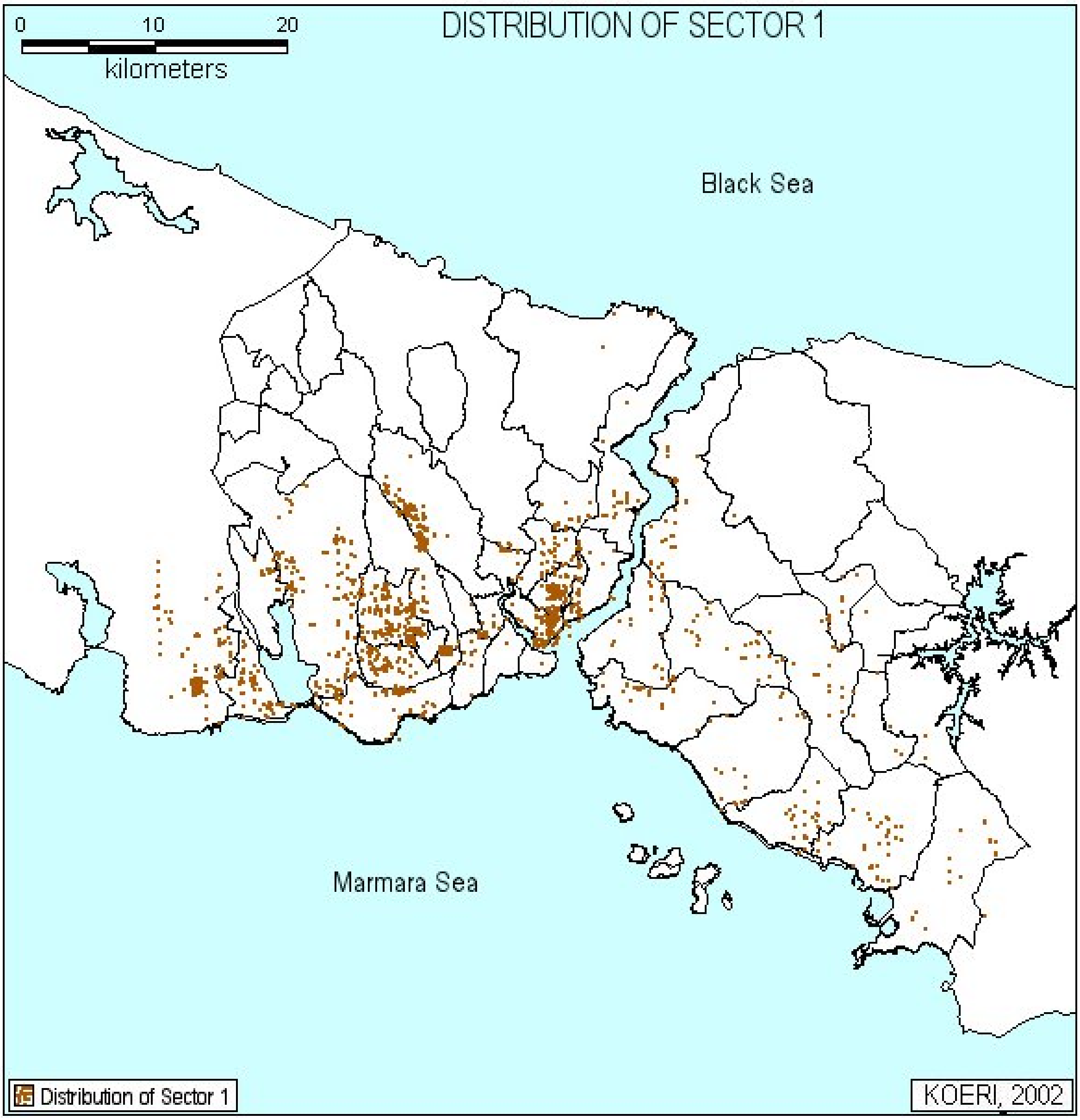


Figure 3.2.1. The distribution of industrial facilities in Sector 1 overlaid on the district (each dot represents one facility).

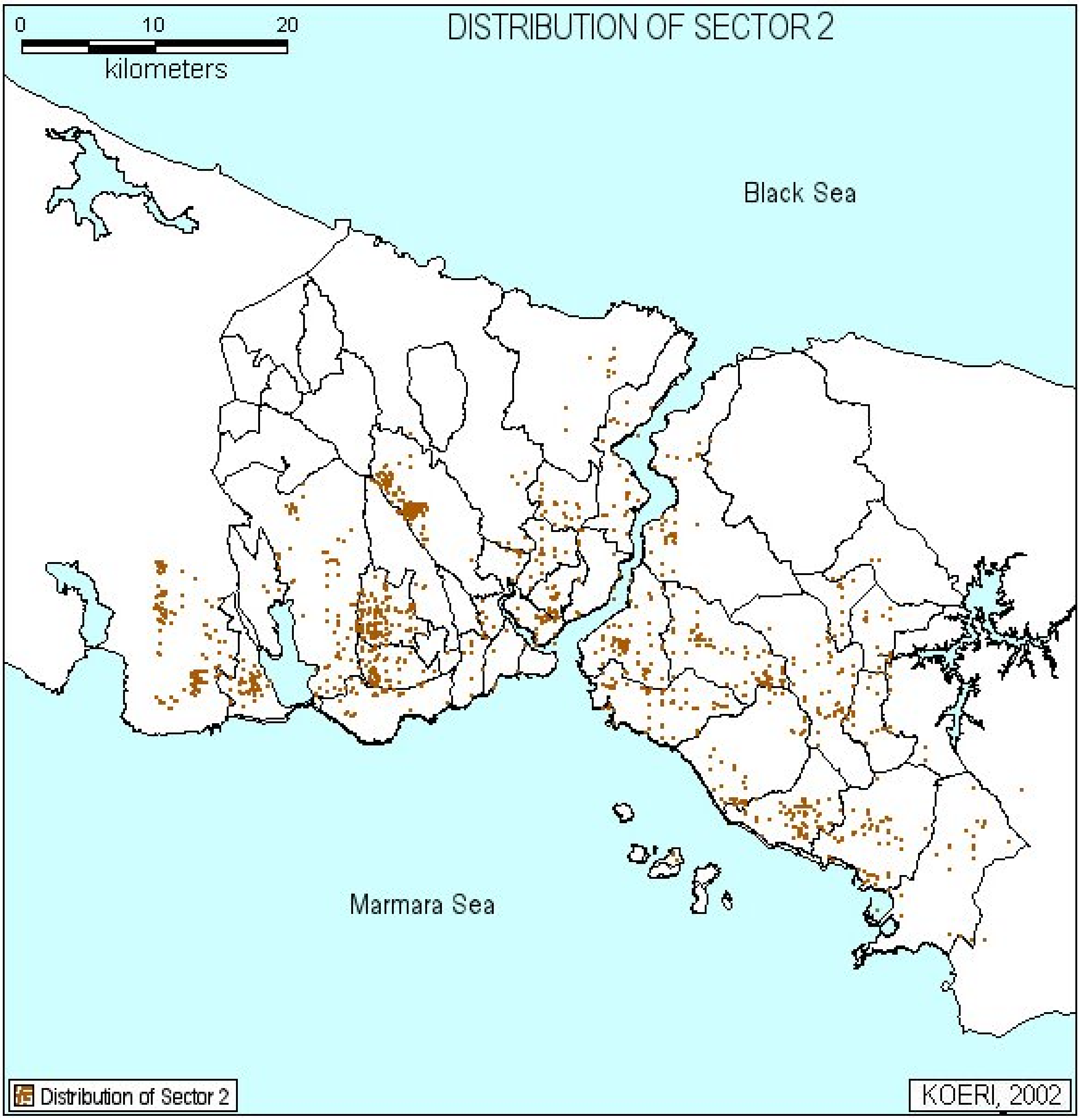


Figure 3.2.2. The distribution of industrial facilities in Sector 2 overlaid on the district (each dot represents one facility).

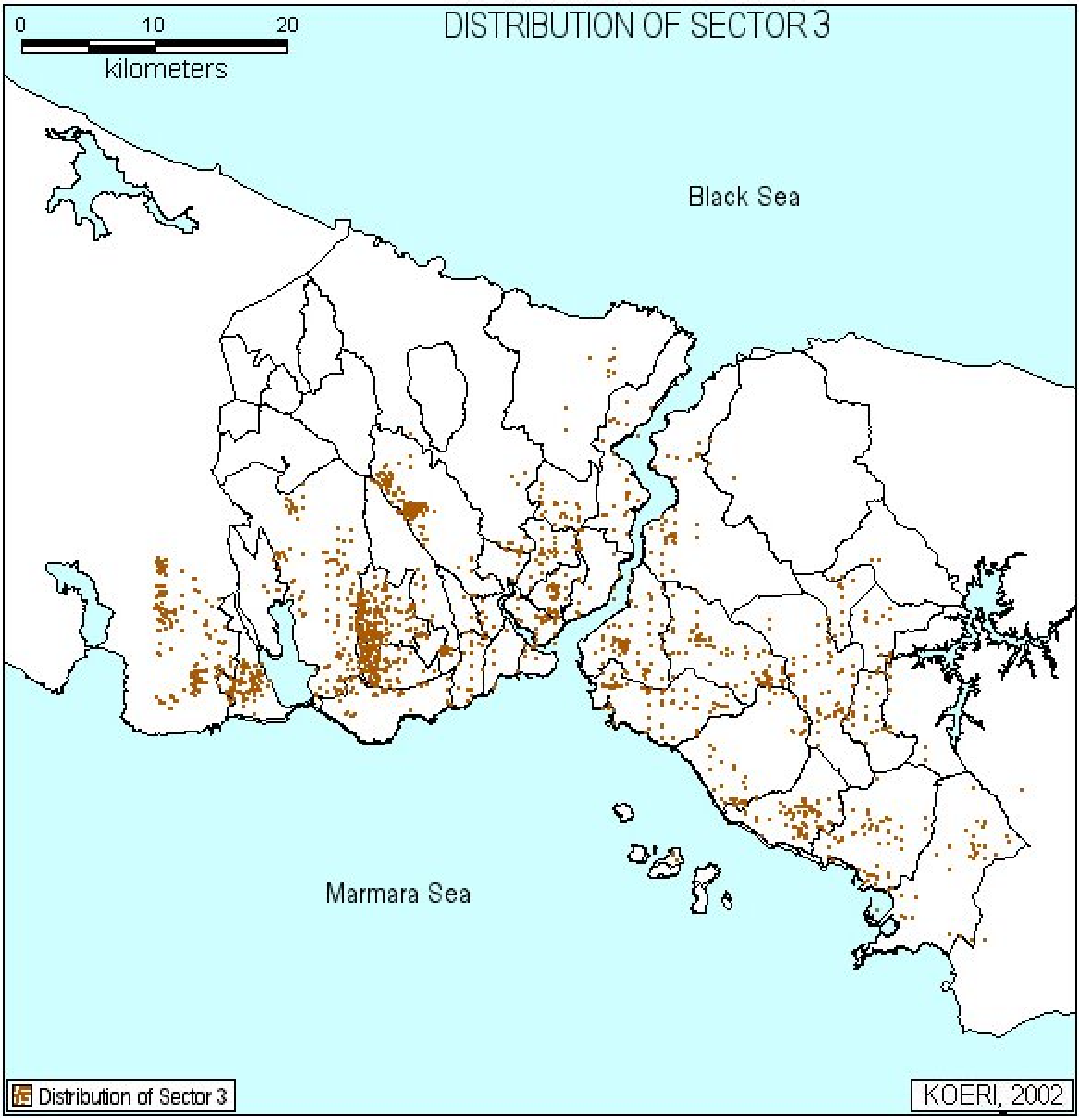


Figure 3.2.3. The distribution of industrial facilities in Sector 3 overlaid on the district (each dot represents one facility).

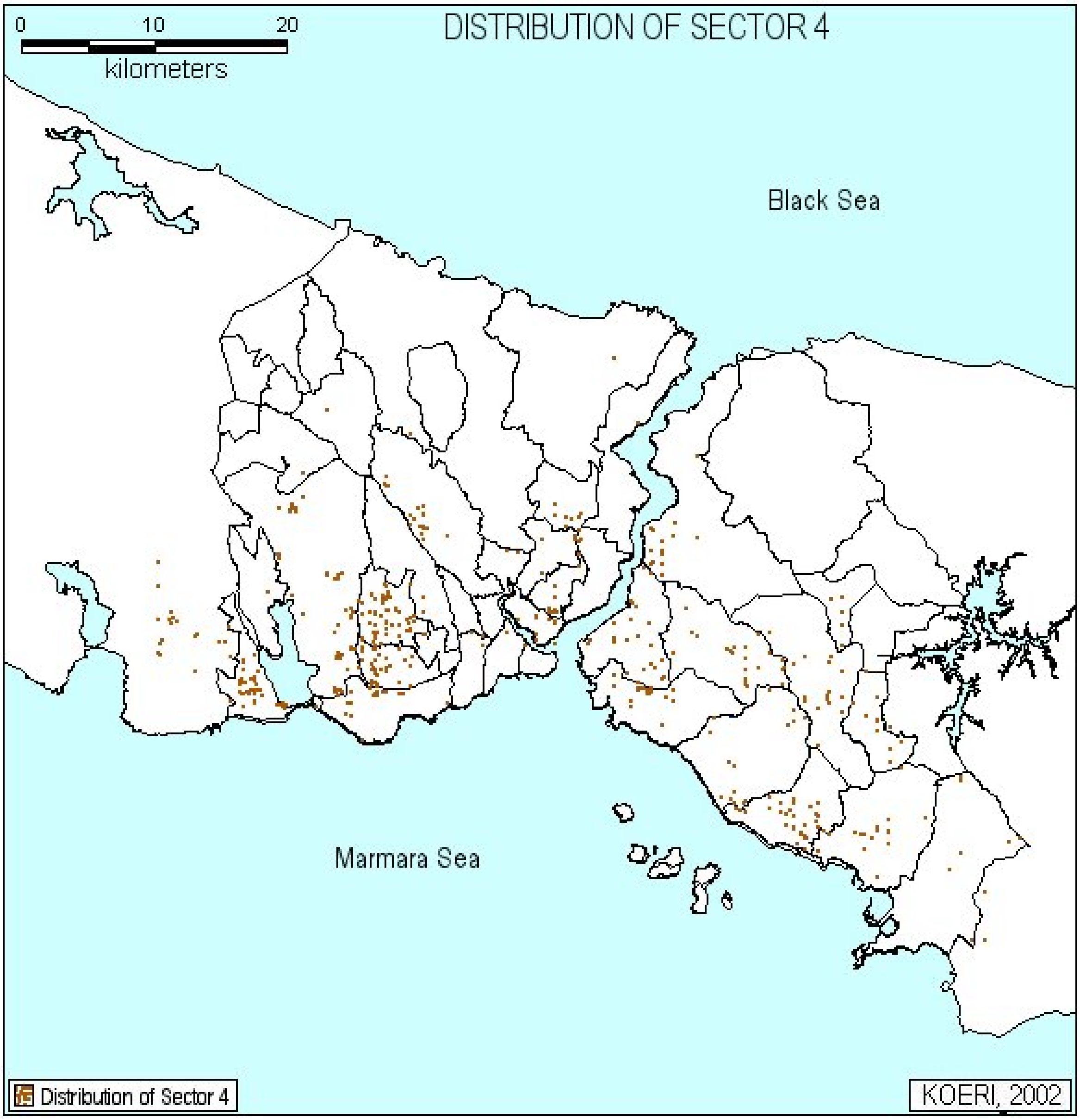


Figure 3.2.4. The distribution of industrial facilities in Sector 4 overlaid on the district (each dot represents one facility).

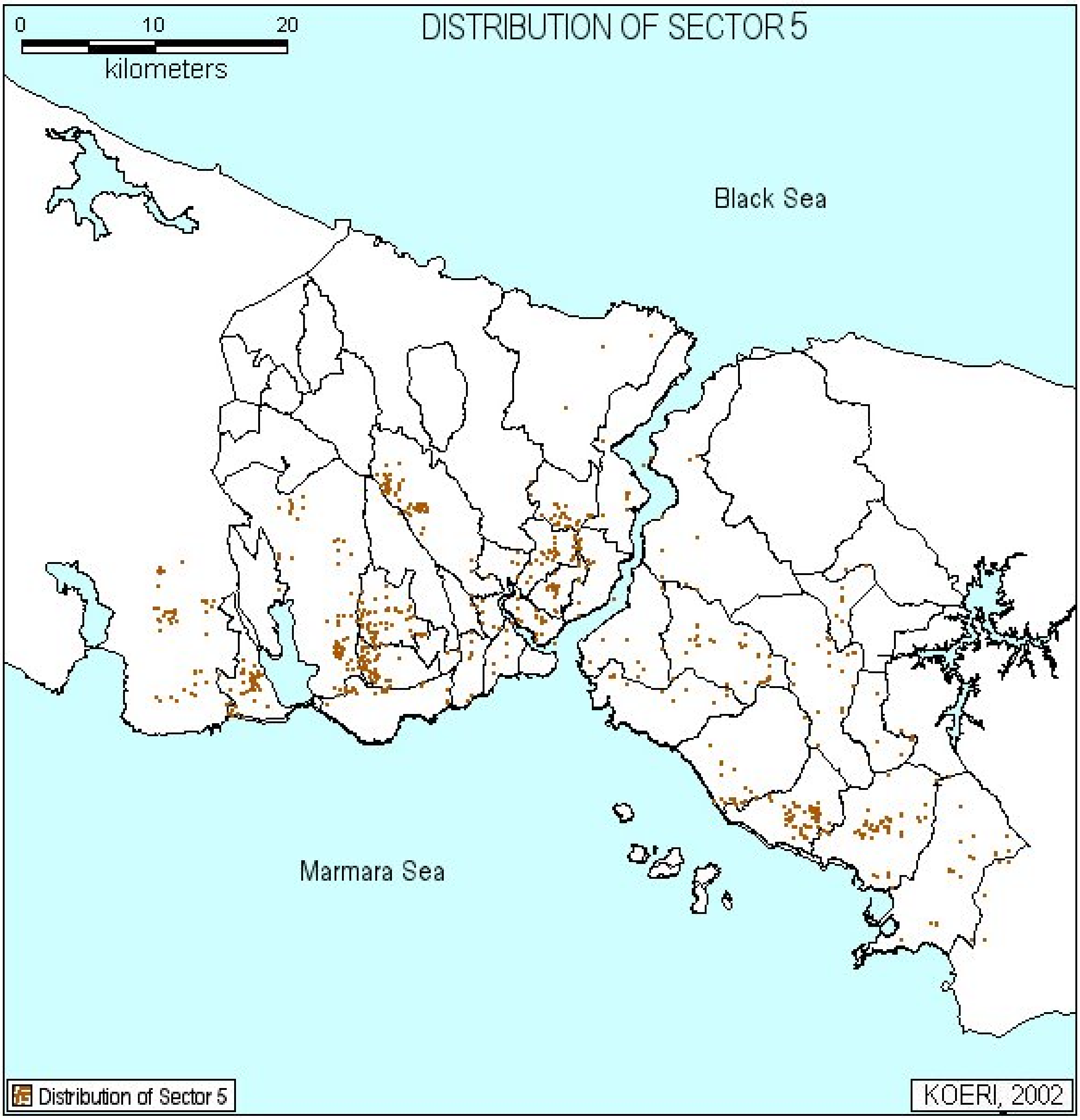


Figure 3.2.5. The distribution of industrial facilities in Sector 5 overlaid on the district (each dot represents one facility).

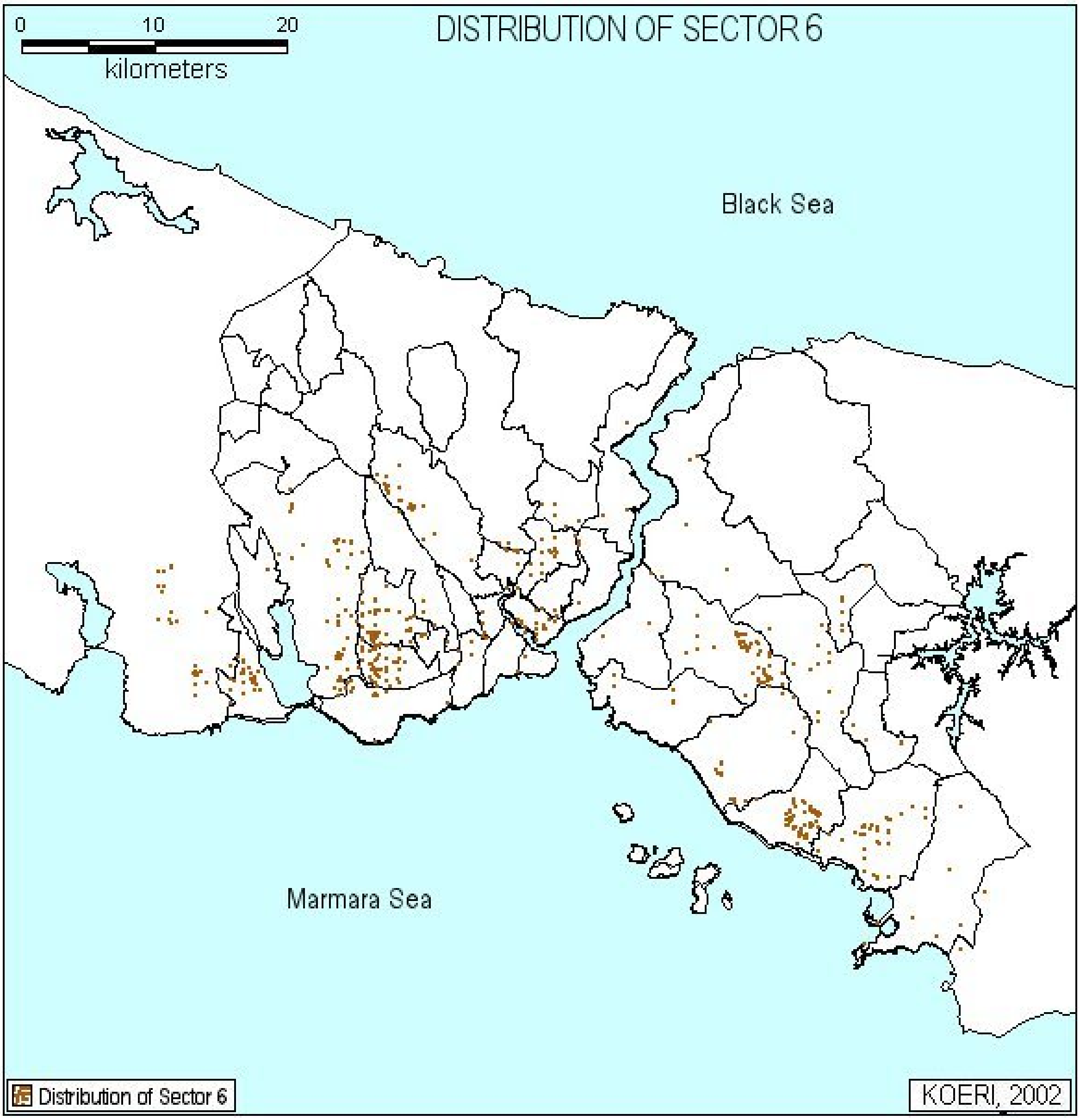


Figure 3.2.6. The distribution of industrial facilities in Sector 6 overlaid on the district (each dot represents one facility).

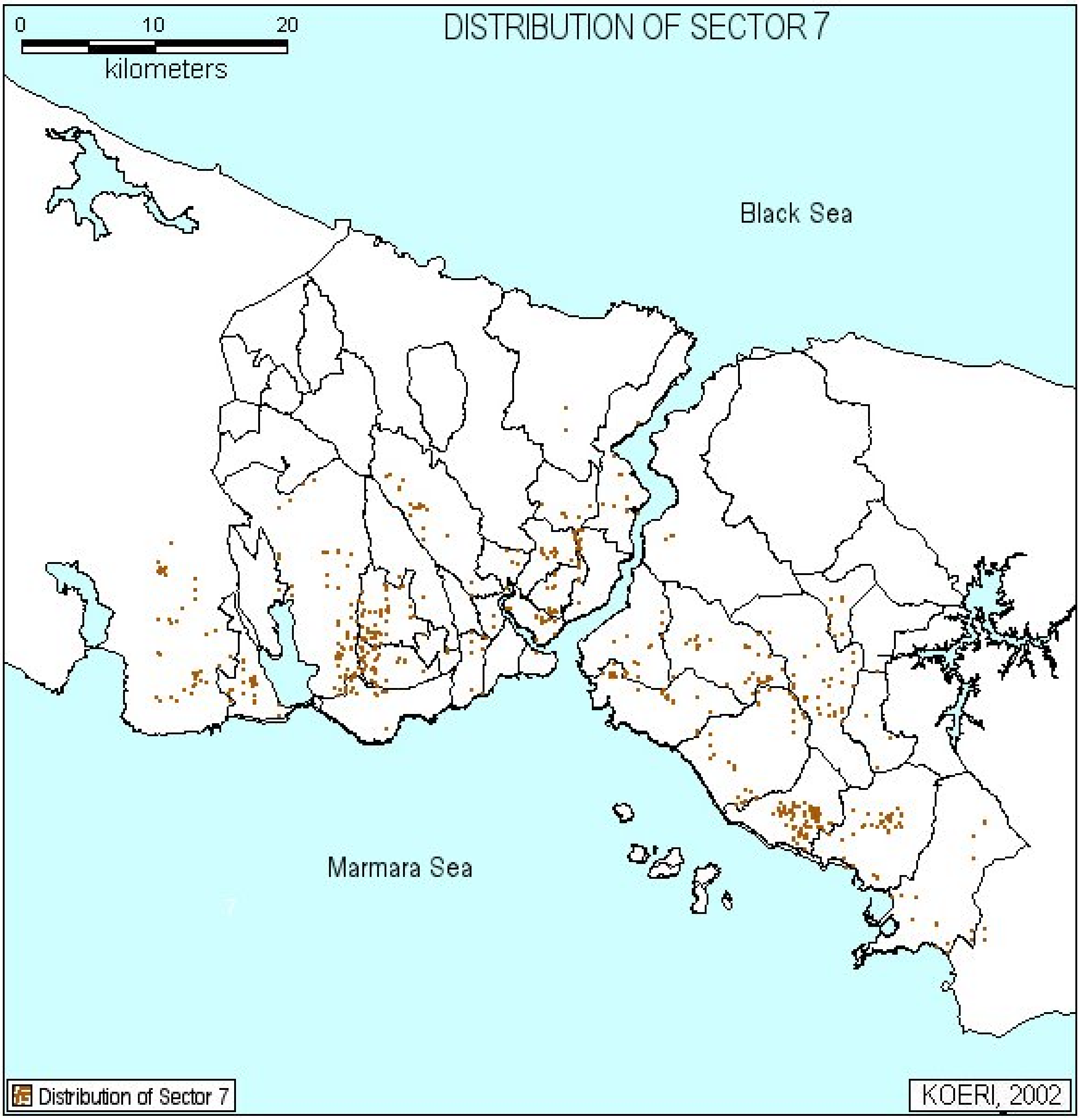


Figure 3.2.7. The distribution of industrial facilities in Sector 7 overlaid on the district (each dot represents one facility).

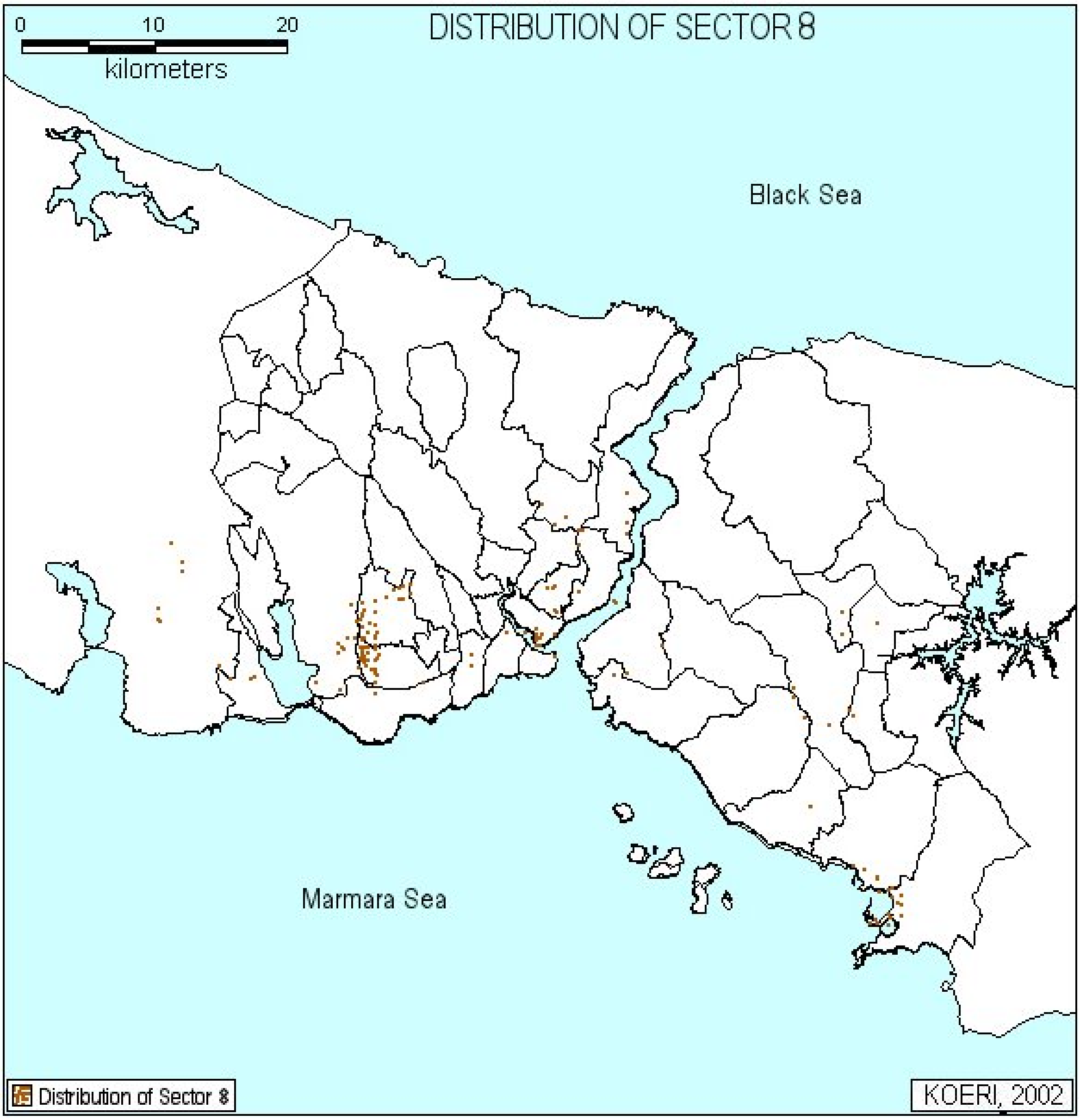


Figure 3.2.8. The distribution of industrial facilities in Sector 8 overlaid on the district (each dot represents one facility).

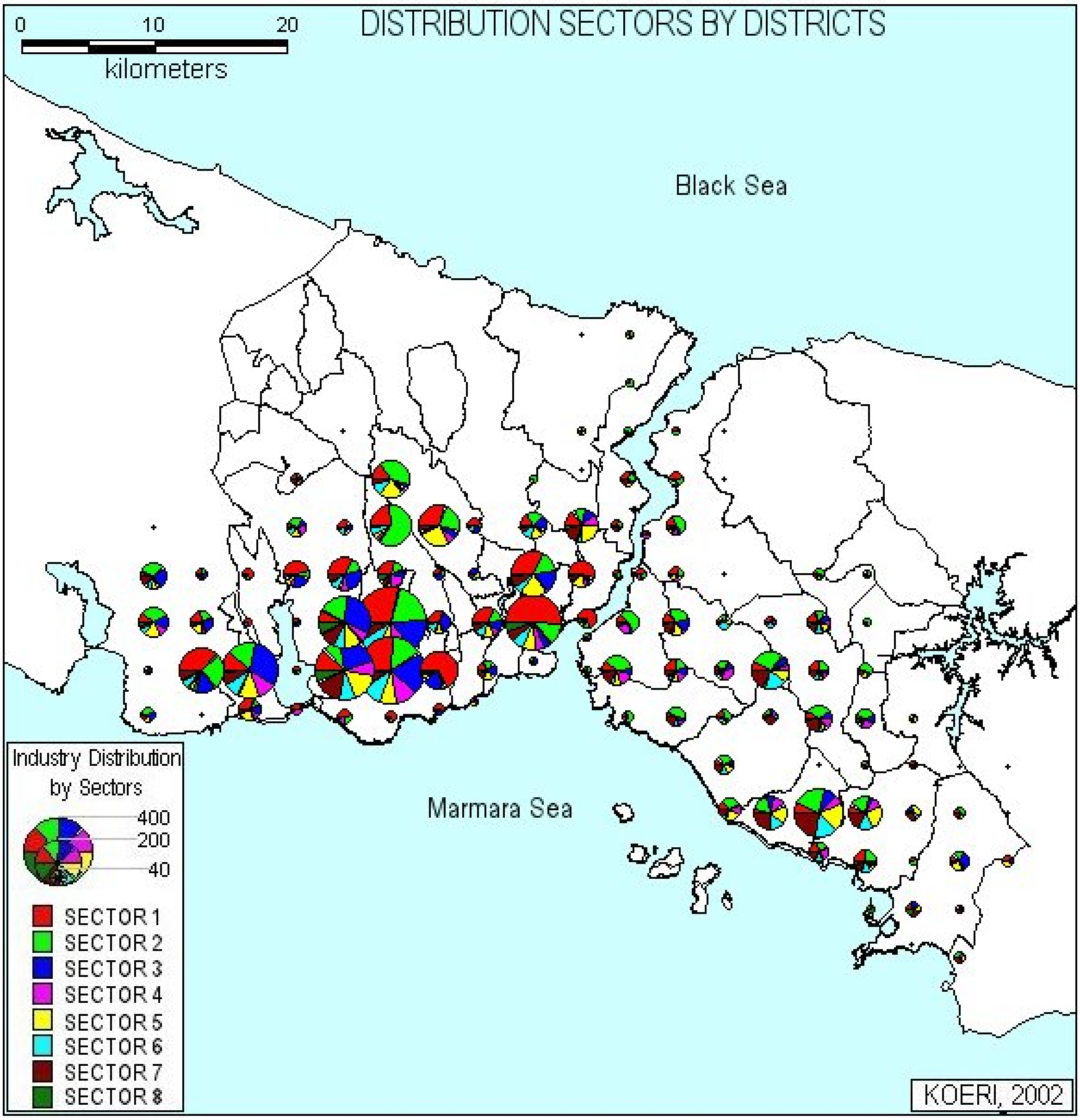


Figure 3.2.9. The pie chart distribution of the eight sector groups for each cell, the size of the pie chart indicating the total number of the industrial facilities in the cell.

3.2.1.2. Municipality Data (1:1,000 GIS Maps)

Another source of information for the compilation of the industrial facility database has been obtained from the Metropolitan Municipality of Istanbul. GIS maps of 1:1,000 scale, gathered from aerial photographs reveal the locations of factories in the city. These locations are illustrated in Figure 3.2.10.

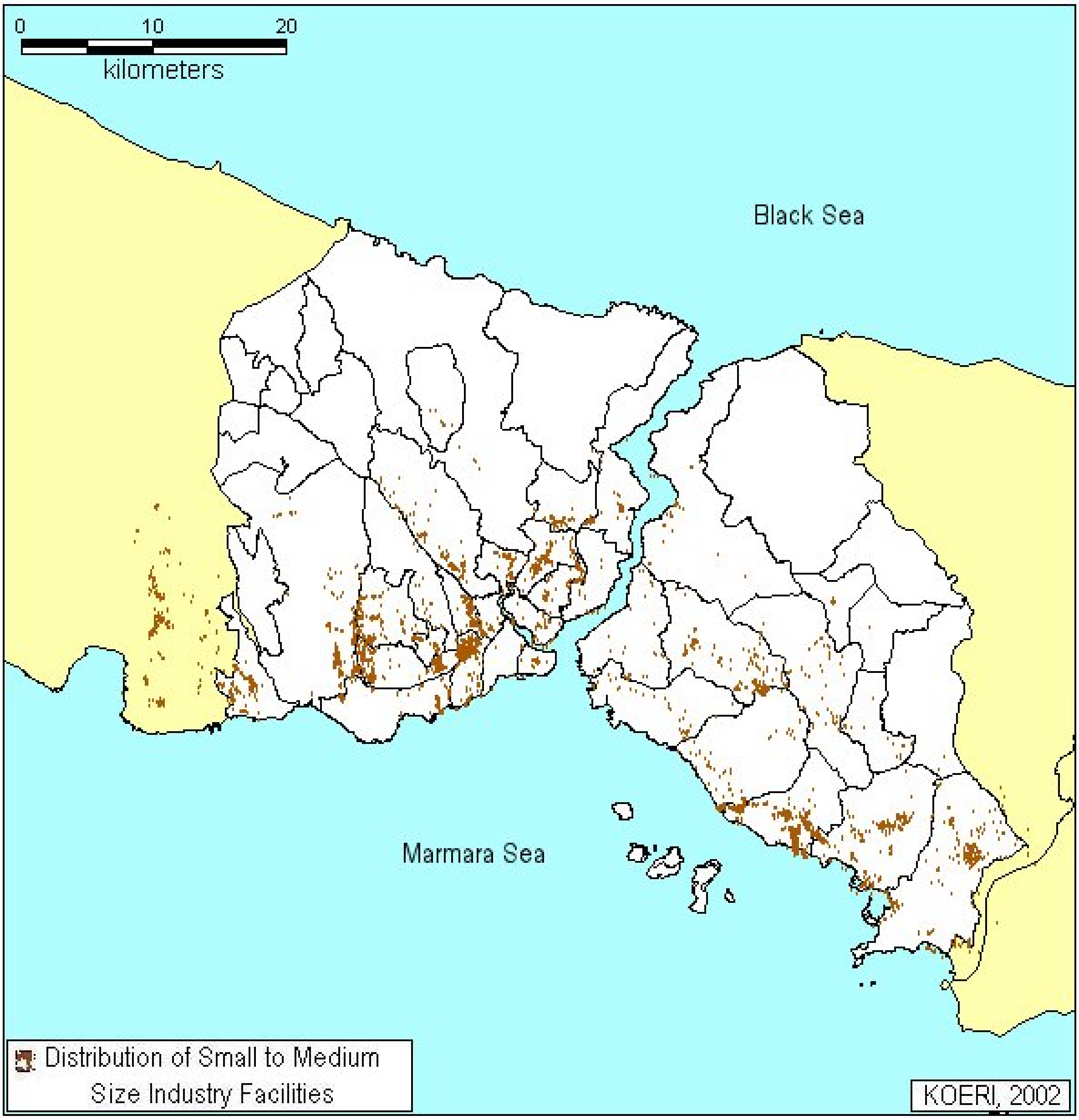


Figure 3.2.10. The distribution of small to medium size industry facilities overlain with the district (from Municipality data).

3.2.2. Large Size Industrial Facilities and Industrial Parks

This section is related to the identification of industrial inventory and sectoral occupancy of large size industrial facilities. The term, “large size industrial facility”, corresponds to a single large size individual facility, or to an industrial park encompassing a multitude of industrial facilities in all sizes, in and around Istanbul in regions exposed to high earthquake hazard. The risk associated with these facilities need to be analyzed separately due to their economical and/or hazardous importance. The earthquake risk estimation of these facilities can also be related to related to the observed earthquake performance of industrial facilities during the past earthquakes.

The survey given here is by no means complete. Only important large scale industrial facilities are considered under the following grouping.

WATER FRONT STRUCTURES

Turkey has several ports and berthing facilities; The ports are classified into three groups: governmental, municipal and private ports.

The first group, general-purpose governmental ports, are operated by State Economic Enterprises. The Turkish State Railways (TCDD) ports, all of which are connected with the railway network. The Turkish Maritime Organization (TDI) ports. These two State Economic Enterprises are under the control of the Ministry of Transport, but they are activating as independent enterprises. In the headquarters of both organizations, there is a separate Department of Ports, which is responsible for planning and their coordination. Each individual port is managed by a Port Manager appointed by the related State Enterprise. All the services to ship and cargo are given by the port own labor and equipment.

The second group are municipal ports which are managed by the Municipalities. These ports are comparatively small and are general limited to a small volume of coastal traffic serving the local needs of provincial towns.

The third group is made up of special private ports. These ports are mostly confined in purpose to the particular needs of industrial plant but allowed to use by third parties too.

Liquid storage tanks, power generation units, cranes, winches, waste water treatment plants, crude oil, and pressurized LNG storage tanks are the most important components of the water front structures in the regions of Dilovası, Tuzla, Ambarlı and Marmara Ereglisi

NDUSTRIAL PARKS

There exists a number of industrial parks in Gebze and Vicinity, İkitelli , Hadımköy and Cerkezkoy and vicinity.

INDIVIDUAL FACILITIES

There exist chemical, petrochemical, steel mills, metal forming, cement and other large size facilities in Gebze, Darıca, Bayramoglu, Silivri and Buyuk Cekmece regions.

The localities of these essential industrial facilities/complexes were identified and several approaches have been used for their survey. The data provided through, (1) Helicopter flights, were used to identify the, building and non building structural components, of the industrial facilities, and (2) Personal contacts, trade unions and municipalities, were gathered and complied together to yield the industrial information in terms of sectoral occupancy and land use. Chapter 3.2.2.1 encompasses the first approach, i.e. data collection by helicopter surveys, whereas results of the second approach will be presented in Chapter 3.2.2.2.

3.2.2.1. Helicopter Surveys

Two flights were realized. Both of them have started and terminated in Çamlica. The routes of these flights were represented by the red and blue colored lines in Figure**.** Since the industrial facilities are concentrated in some specific locations, the organization of this Chapter is based on the information of critical facilities at selected localities, numbered from, A1 to A4 on the Asian side and, E1 to E6 on the European side, (Figure 3.2.11). These industrial concentrations correspond to the following localities:

A1: Dilovası and vicinity
Ports(1), Hazardous (1) , Large size (1)
A2: Gebze and vicinity
Industrial Parks(1) , Large size (2)
A3: Tuzla and vicinity
(Ports(2)+Industrial Parks(2)
A4: Haydarpaşa and Moda
Ports(3)

and,
E1: Ambarlı and vicinity
Ports(4) – Hazardous (2)
E2: Marmara Ereğlisi and vicinity
Ports(5) – Hazardous (3)
E3: Çerkezköy –Çorlu and vicinity
Industrial Parks (3)
E4: Hadımköy and vicinity (Industrial Parks4)
E5: İkitelli and vicinity
Industrial Parks (5)

The locations of these essential industrial facilities overlain with the deterministic intensity map are presented in Figure 3.2.12. Both due to its close distance to the fault and the high concentration of industrial facilities, the Tuzla, Gebze and Dilovasi region is considered to carry the highest risk. An enlarged view of the intensity map for this region, together with the locations of the essential facilities, is presented in Figure 3.2.12.

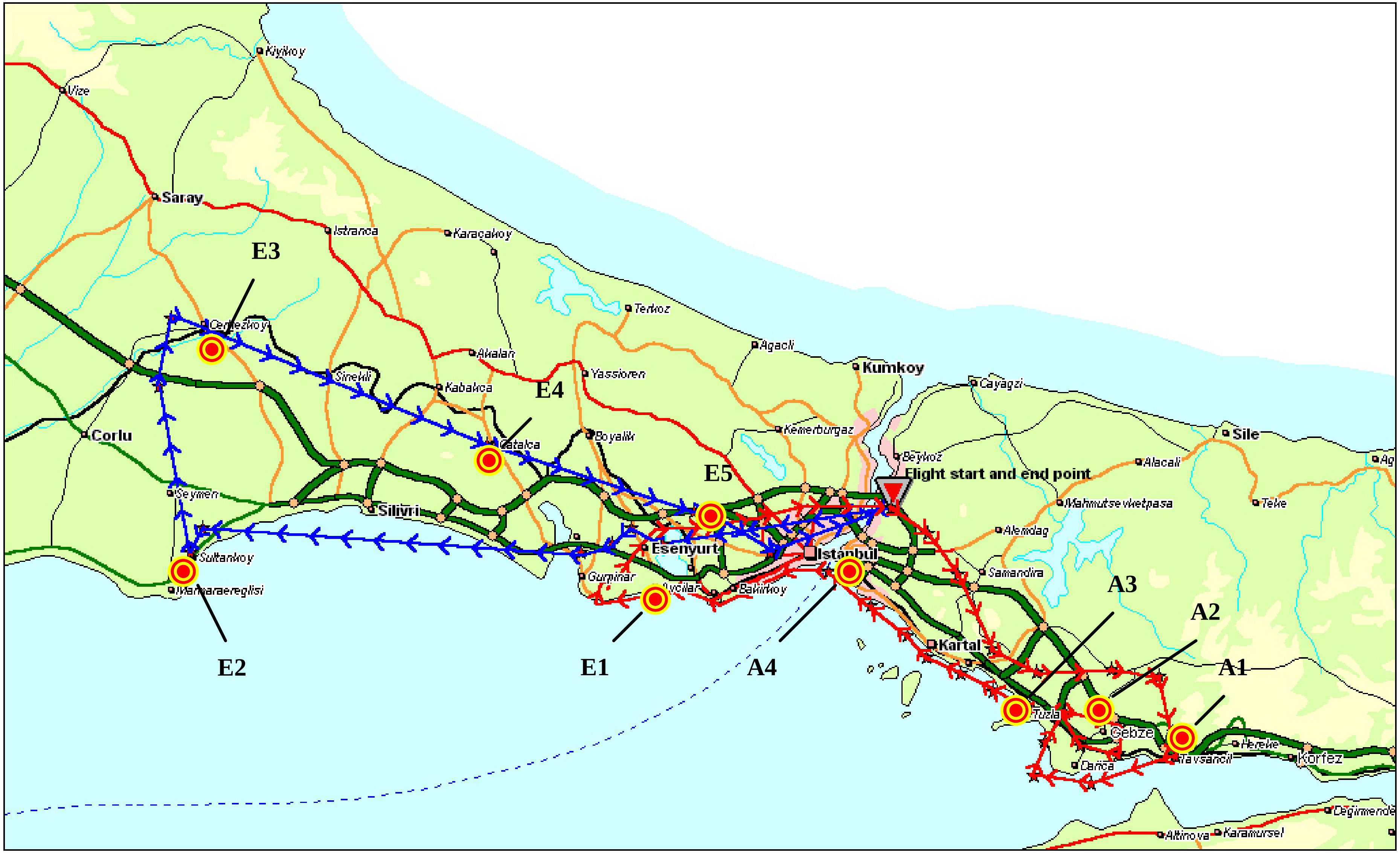


Figure 3.2.11. The route of helicopter flights and the large scale industrial facilities.

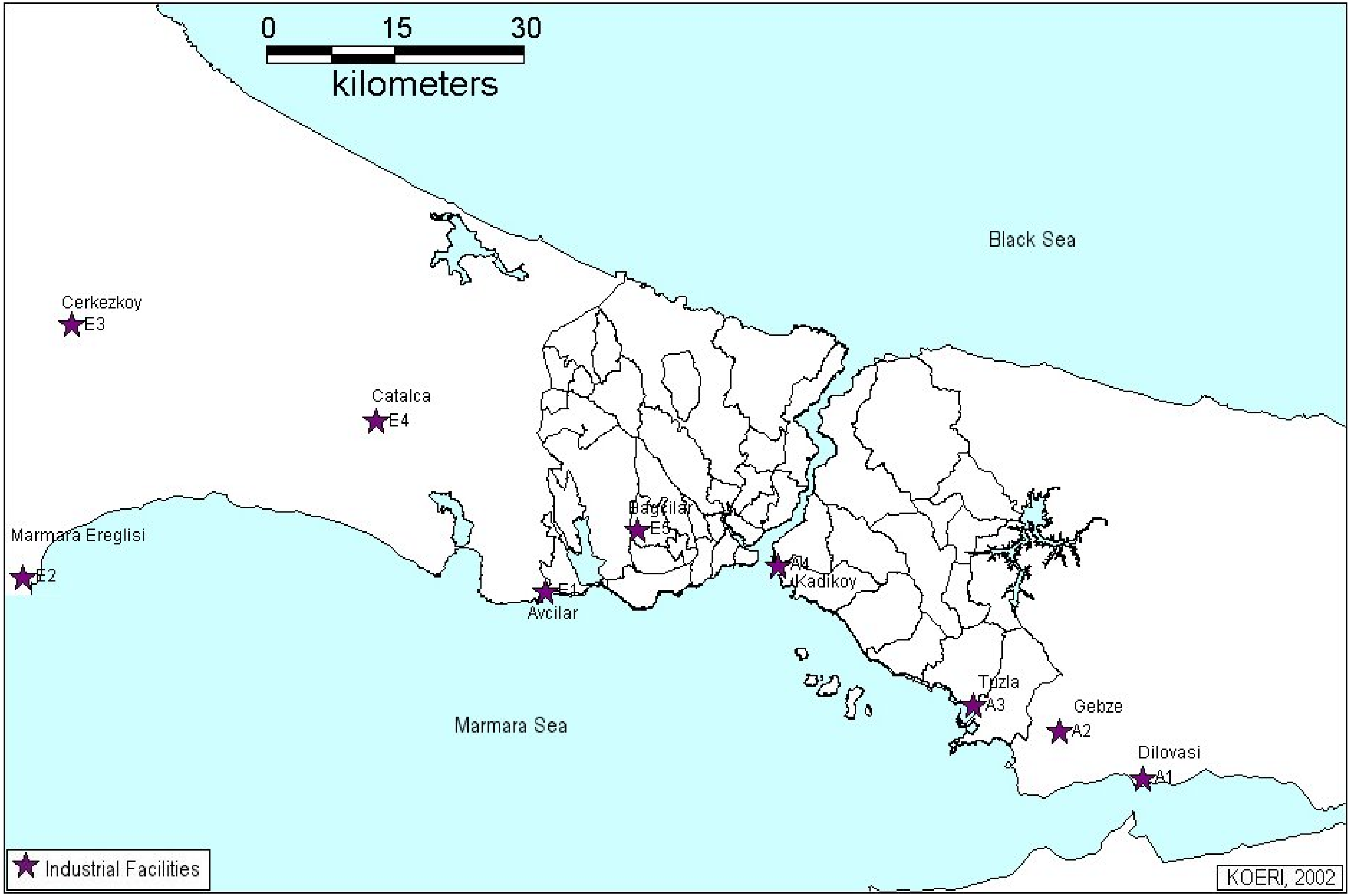


Figure 3.2.12. Locations of essential industrial facilities (industrial parks and large size facilities) overlain with the district map.

3.2.2.2. Components of the Industrial Facilities Considered

The type of the structural components at these indicate their seismic vulnerability The seismic vulnerability of an industrial facility is a matter of significant economic and life safety consequence and needs to be analyzed by considering three major components; building structures, non-building structures and non structural elements. The building and non building (structural and non structural) components in these locations show great sectoral variations. These components can be itemized as:

Building structures;
- Prefabricated (P.F.)
- Steel
- Reinforced Concrete (R.C.)

Non-building structure;
- Pressurized tanks, vessels, power generators, storage areas , towers, chimneys, silos, port structures/jethes and cranes.

Generally following types of building and non building structural components exist in these localities.

1) Dilovası (A1): Port structures, storage tanks, chimneys, power generation.
2) Gebze (A2): Storage tanks, power generation, steell mills.
3) Tuzla- coastal line (A3): Port structures, cranes.
4) Tuzla- (North) (A2): Waste water treatment plant – and industrial parks building structures.
5) Haydarpaşa Custom A(4): Port structures and cranes.
6) Ambarlı Petro Chemical (E1): Port structures, hazardous structures and cranes.
7) Marmara Ereğlisi (E2): LNG storage tanks and port structures.
8) Cerkezkoy and Corlu (E3): Textile industry and industrial parks.

Çatalca, Hadimkoy and Ikitelli (E4 and E5) -

The sectoral distribution at these industrial concentrations vary from, petro chemical, chemical, metal, transportation, textile, leather, machinery to steel mills.

Owing to their proximity to the Main Marmara Fault, special attention will be paid to the water front structures in Dilovası (A1), Tuzla (A3) and Kaynarca (A3), on the Asian side, and Ambarlı (E1) and Marmara Ereğlisi (E2) on the European side. In the first flight, it was aimed to cover the southern and northern zones of the Asian side, up to Dilovası on the east and Buyuk Cekmece on the west. In addition to the essential facilites in Dilovası region, special emphasis was also given to some of the facilities in the central region of Gebze. In the second flight more emphasis was placed on the European side up to Marmara Ereglisi on the west. The facilities in the neighboring cities such as, Çorlu and Çerkezköy were also surveyed. The video and/or image files of these facilites are available in “avi” and “jpg” formats. The flight covers information related to the facilities located along the southern coast at Ambarlı, Büyük Çekmece and along the southern cost and Marmara Ereğlisi and Çerkezköy, Çorlu, Hadımköy and Ikitelli along the northern region. Similar to the distribution of facilites in the Asian side medium to large size individual facilities such as petro chemical and critical facilities (on fill areas) were seen to be located along the southern coast, whereas industrial parks and organized industrial zones/complexes are located towards the northern regions.

The most important facilities to be considered on the European side are the hazardous/critical water front structures, whereas on the Asian side, the steel plants and power generation units in Gebze and Dilovası need to be considered also.

(A1) Dilovasi and Vicinity

The district of Dilovası can be considered to be one of the most important zones due to the heavy density of the industrial facilities, wide spectrum of sectoral variation, critical water front structures and high seismic hazard. Turkey's one of the most industrialized regions, home to much of Turkey's heavy industry, including petrochemical plants, steel fabrication plants, pharmaceutical firms, and other industries. The rate of increase in the number of industrial facilities in the Dilovası region for a period of three years (from 1997 to 2000) is reported to be, 45 % (Municipality of Dilovası). Thus special attention needs to be focused on this region.

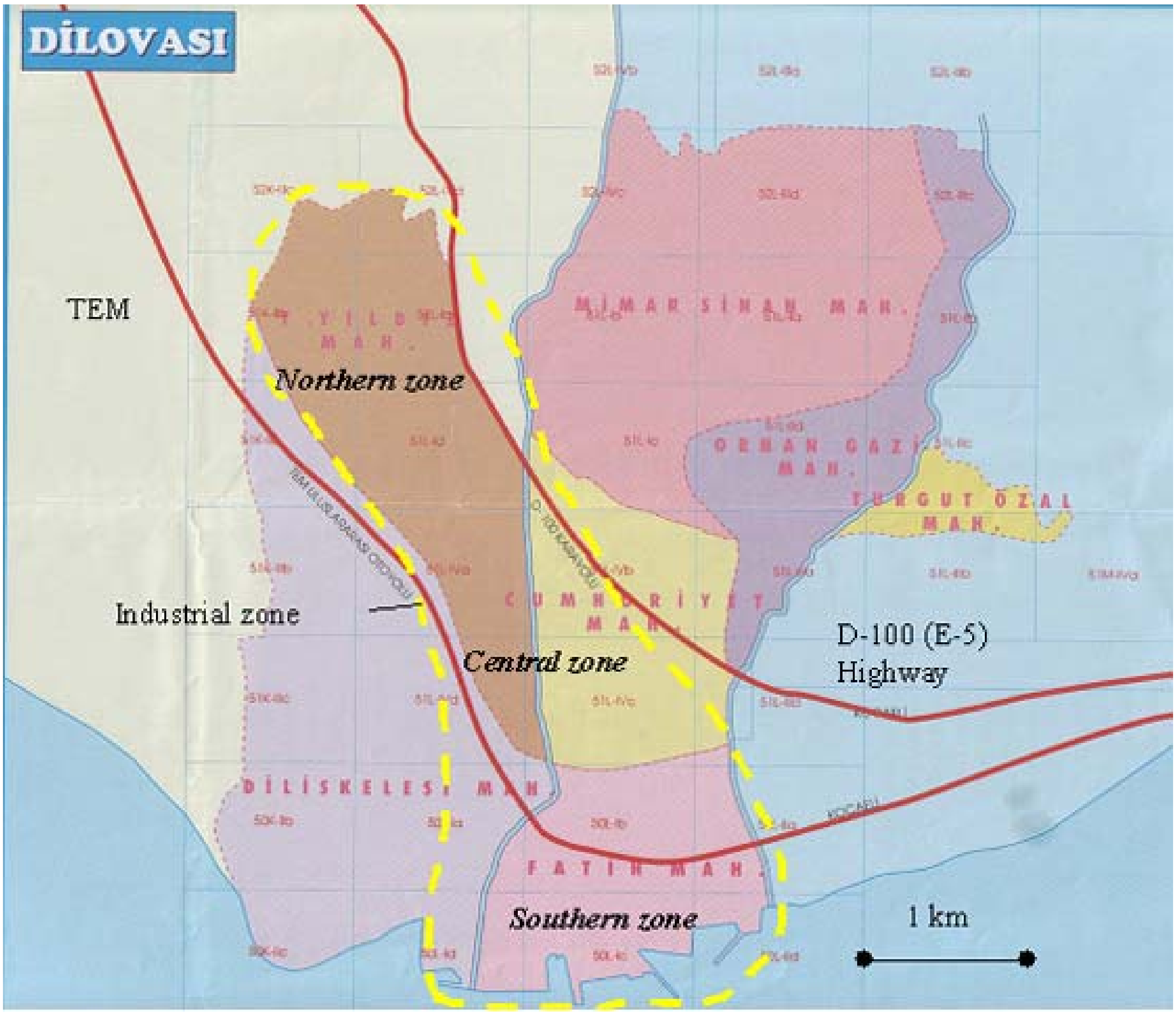


Figure 3.2.13. General map of the Dilovasi region.

The total area of the industrial zones is nearly equal to that of the residential area, and in general, the Dilovası region can be divided into three zones: (1)Southern, (2) Central and (3)Northern, zones.

During the 1999 Kocaeli Earthquake, the structures of central zone suffered hands of various damage due to soil amplification in the Dilovası Basin and the northern zone was affected by land sliding. The southern zone, on the other hand, can be considered to be the most critical one among the others, due to its proximity to the fault line.

The most critical facilities operating in the whole region are, Colakoglu Metalurji, Diler Demir Celik, Lever, Izocam, Botas Boru, Olmuksa Mukavva, Polisan Kimya,Atabay Kimya, Yasar Boya, Basf Sumerbank and Marshall Boya.

After the compilation of the limited data provided by the municipality of Dilovası, following pie chart was derived. Herein, only essential industrial facilites were considered to represent the overall sectoral distribution.

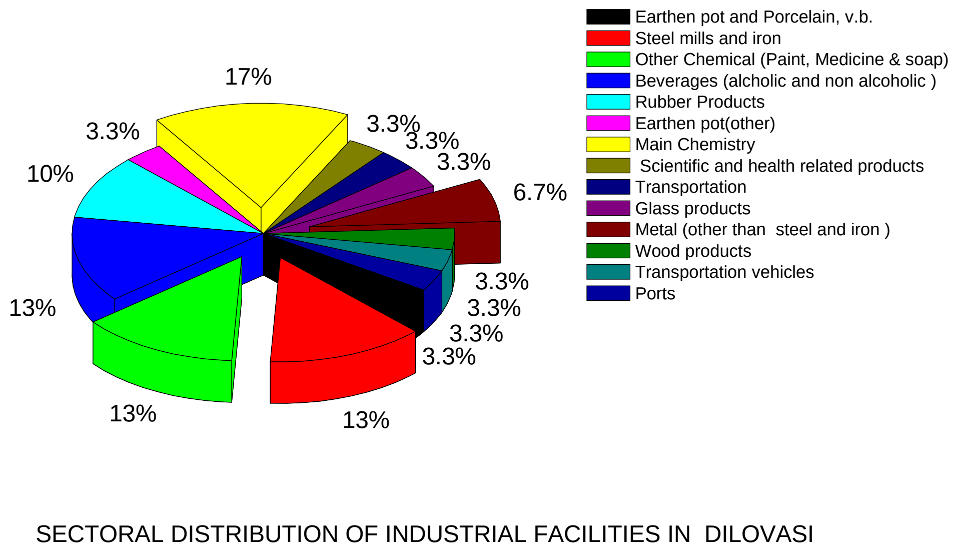


Figure 3.2.14. Sectoral distribution of industrial facilities in Dilovası.

From the chart above, it can be seen that, chemical and metal industries cover nearly 50 % of the overall industrial occupancy and also the beverage sector participate in a considerable amount (13%).

Further data are required to provide a more reliable distribution for the sectoral distribution of industrial facilities in the Dilovası region. The data provided by the Trade Union of Gebze (G.T.O) were also compiled and presented in the following section, A2 (Gebze and vicinity), for Gebze and Dilovasi regions. The distribution of essential structures at the southern, central and northern zones of Dilovası basin are shown on the topography maps which were provided from the municipality of Dilovası.

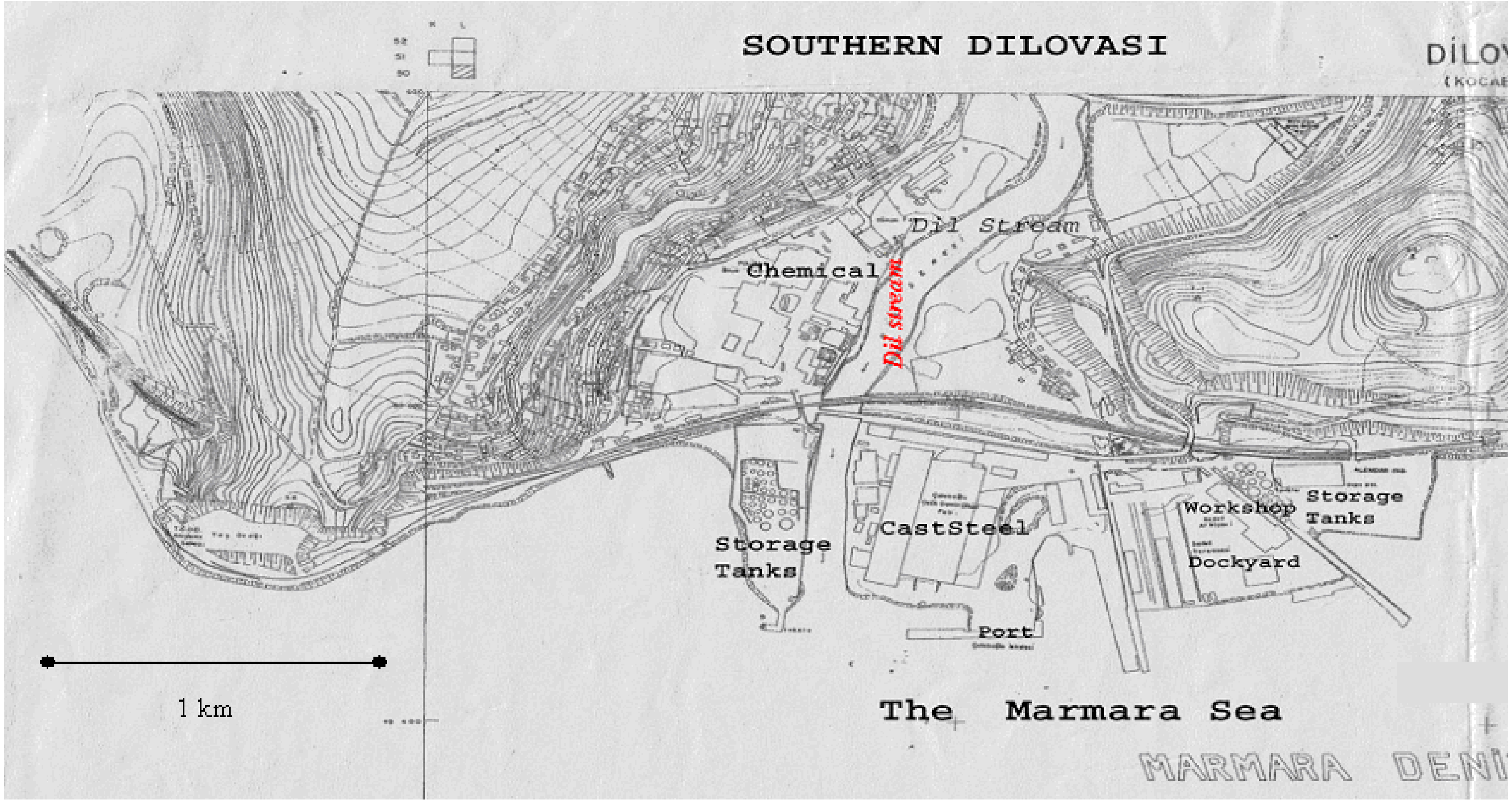


Figure 3.2.15. The southern Dilovası

Zone 1: (Southern zone)

This zone lies in the southern region of the TEM and majority of the structures can be assumed to be water front structures (port structures and storage tanks). The subsoil of the port area is known to be soft and some of the port structures founded in this region have received considerable amounts of damage during the Kocaeli 1999 Earthquake.

Figure 3.2.16. Aerial view of southern Dilovası (from east).

A significant amount of group of tanks containing liquids are subjected to severe earthquake risks due to liquefaction.
The companies Çolakoğlu, Polsa (chemical) , Sedef Gemi, Alemdar, Solventaş, and Beld Liman are the major facilities located in this zone(data sources: Cerrahoglu Tic.T.A.S). Essential components are, port structures and storage tanks.

Figure 3.2.17. Aerial view of the water front structures in southern Dilovası (from south-west).

The facility ***Poliport*** is being operated by Polisan Kimya San. Ve Ticaret A.S. The main activity of the facility is storage of liquid chemical, oil, petroleum products and dry cargoes. There exists two jetties for liquid cargoes for discharging and loading. No shore cranes are available on jetties. The cargo handling equipments are, mobile cranes , weigh-bridge and the load/unload rate is 2.000 mts/day for cargoes in bulk. There also exist pipe lines from the jetty-platform to the shore tanks. Shore tank storage capacity is 1 82 tanks with a total cap. of 52.000 m3.

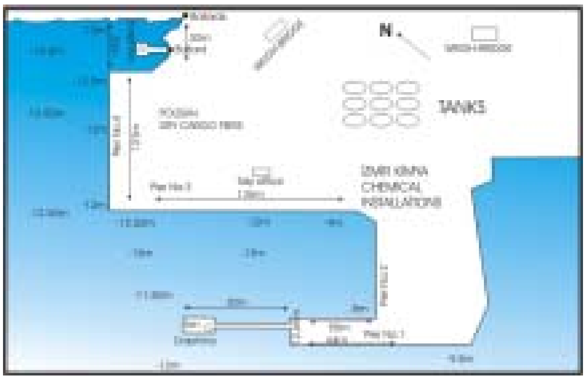


Figure 3.2.18. Port of Polisan (Data sources: Cerrahogullari Tic.T.A.S, web site)

The facility ***Colakoglu*** is being operated Colakoglu Metalurji A.S. Main activity of the facility is loading and discharging of iron and steel products. Liquids and dangerous cargoes are unaccepted.

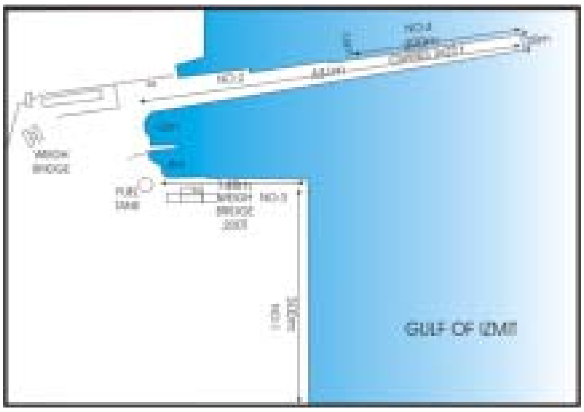


Figure 3.2.19. Port of Colakoglu

The facility ***Sedef*** is being operated by Sedef Gemi Endüstrisi A.S. The main activity of the facility is loading and unloading containers (geared vessels) and steel products.

Annual container handling capacity is 75,000 teu and stacking capacity is 5,000 teu. 800,000 tons of general cargo can be handled a year. There is 2,400m2 of covered area.4,000m2 of parking area is available for trailers, trucks and other vehicles. Discharging rates are 1500/3000 mts/day for steel products;. 1000/2000 cbm/day Logs/timbers,. 1000/2500 mts/day for bags and 50 trailers/hour Ro-Ro.

The port has top lifter, side lifter,forklifts, and terminal tractors and terminal/port stocking capacity is 65.000 sqm Stacking Areas 70,000 m² total, 63,500 m² open stack, 4,000 m² port sides,2,400 m² covered.(warehouse 2,400 m² covered area and storing service for all kinds of general cargo). Cargo EQUIPMENTS are, portal cranes and overhead cranes used for general cargo handling in the warehouse.

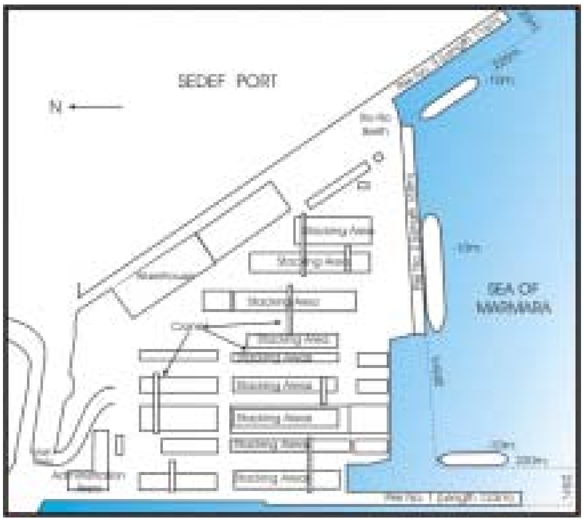


Figure 3.2.20. Port of sedef

The facility ***Alemdar*** is being operated by Alemdar Diliskelesi Liman Isletmeleri A.S. Alemdar port consists of 4 berths, 6 pipe-lines, a tank terminal, an open storage area, warehouses, All under custom control (bonded area), (Major industries using oleo chemicals are soap, plastics, rubber, petrochemical, paint, food, paper, lubricating greases, explosives, candles, emulsifiers, cosmetics, pharmaceuticals, chemical intermediates, textile and leather auxiliaries, etc.

The main activity is general cargo (dry and bulk), fast and oils, chemicals, solvents and petroleum products. The TANK TERMINAL consists of custom bonded 86 tanks from 120 m3, up to 5270 m3, with a total capacity of 92.223m3, equipped with heating coils. Port has mobile cranes and weigh-Bridges.

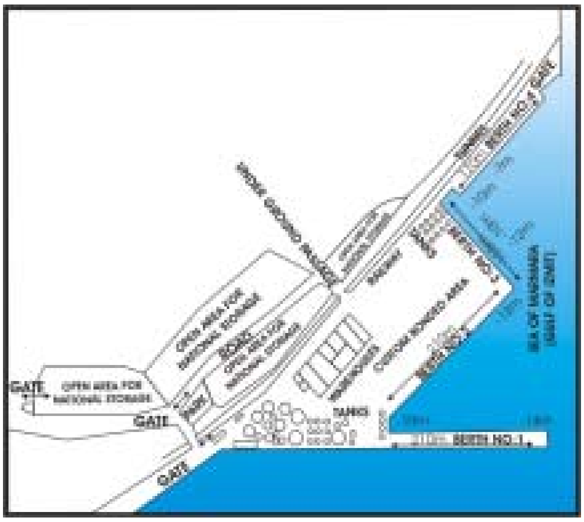


Figure 3.2.21. Port of Alemdar

The facility ***Altinel Piers*** is being operated by Altintel Liman Isletmeleri A.S. The main activity is , loading and discharging iron and steel products and general cargo. There exist open storage area of : 58.500 sqm and 200 sqm and covered area with 38 tanks having a total capacity of 35.000 cbm. The cargo handling equipments are mobile cranes, forklifts and weigh-brides.

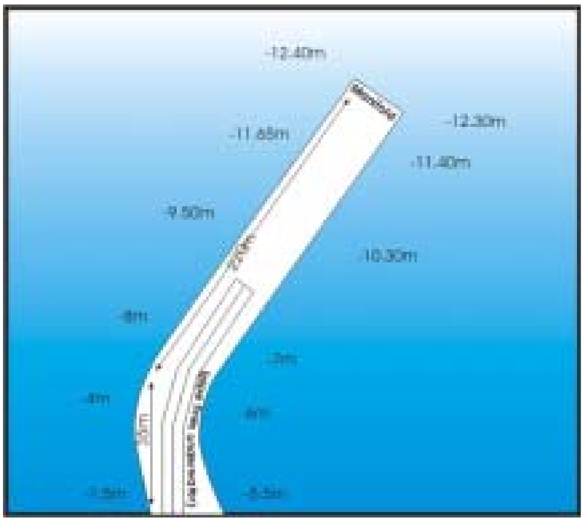


Figure 3.2.22. Port of Altinel Piers

The facility ***Solventas*** is being operated by Solventas Teknik Depolama A.S. The main activity is to serve for loading, unloading, storing, automatic drumming, blending, and automatic line blending for fuel-oil and gas-oil, also laboratory testing for quality control. The Terminal, as a whole, is a bonded warehouse for bulk and dry chemicals spread on 25 acres at the Izmit Bay shore of the Marmara Sea. The storage area consists of 142 mild steel storage tanks (coated, uncoated ; heated, unheated) in different capacities from 108 m3 to 4300 m3. There exist ship docks for loading and unloading of vessels up to 50.000 DWT. There also exists liquid waste removal tanks of 200 cbm capacity and a 50 m³ biological reactor for domestic and industrial waste water treatments.

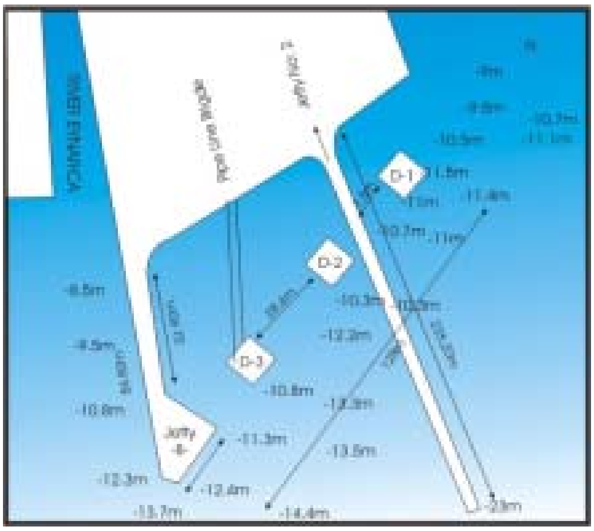


Figure 3.2.23. Port of Solventas

The facility ***Kizilkaya Pier*** is being operated by Istanbul Demir Celik Fabrikalari A.S. The main activity is loading and discharging coal, logs, bulk cargoes, iron and steel products, Cargo handling equipments are mobile cranes and a weigh bridge. The berthing capacity is up to 50.000 DWT vessels.

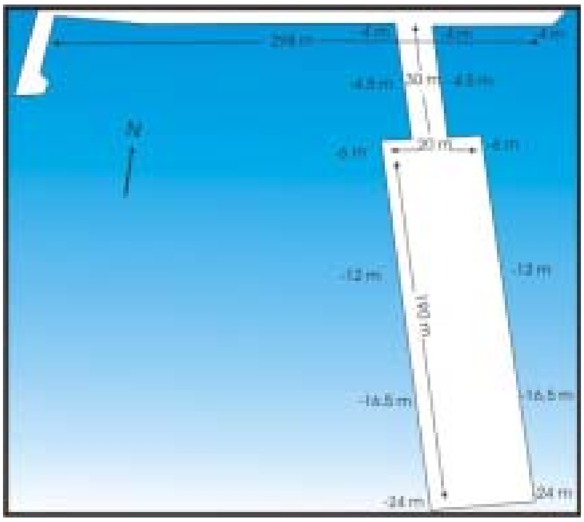


Figure 3.2.24. Port of Kizilkaya Pier

Submarine landslide or ground settlement due to liquefaction can cause damage to port and harbor structures. Ground subsidence can damage berths, and earthquake induced sloshing can cause damage to steel tanks.

Figure 3.2.25. Typical P.F. building structures used as workshops and/or warehouses in southern Dilovası (from north).

Figure 3.2.26. Typical building structures, storage tanks and cranes in southern Dilovası.

During a large earthquake, damage may occur in the forms of, failed cranes, building collapses, collapse of steel-framed structures, storage rack collapses, damage to ports, and severe equipment and nonstructural damage. A collapsed crane(s) at a steel mill factory can cause appreciable amount of damage to the facility

Zone 2: (Central Dilovası)

The central Dilovası is founded on the Dilovası Basin(Figure 3.2.27).

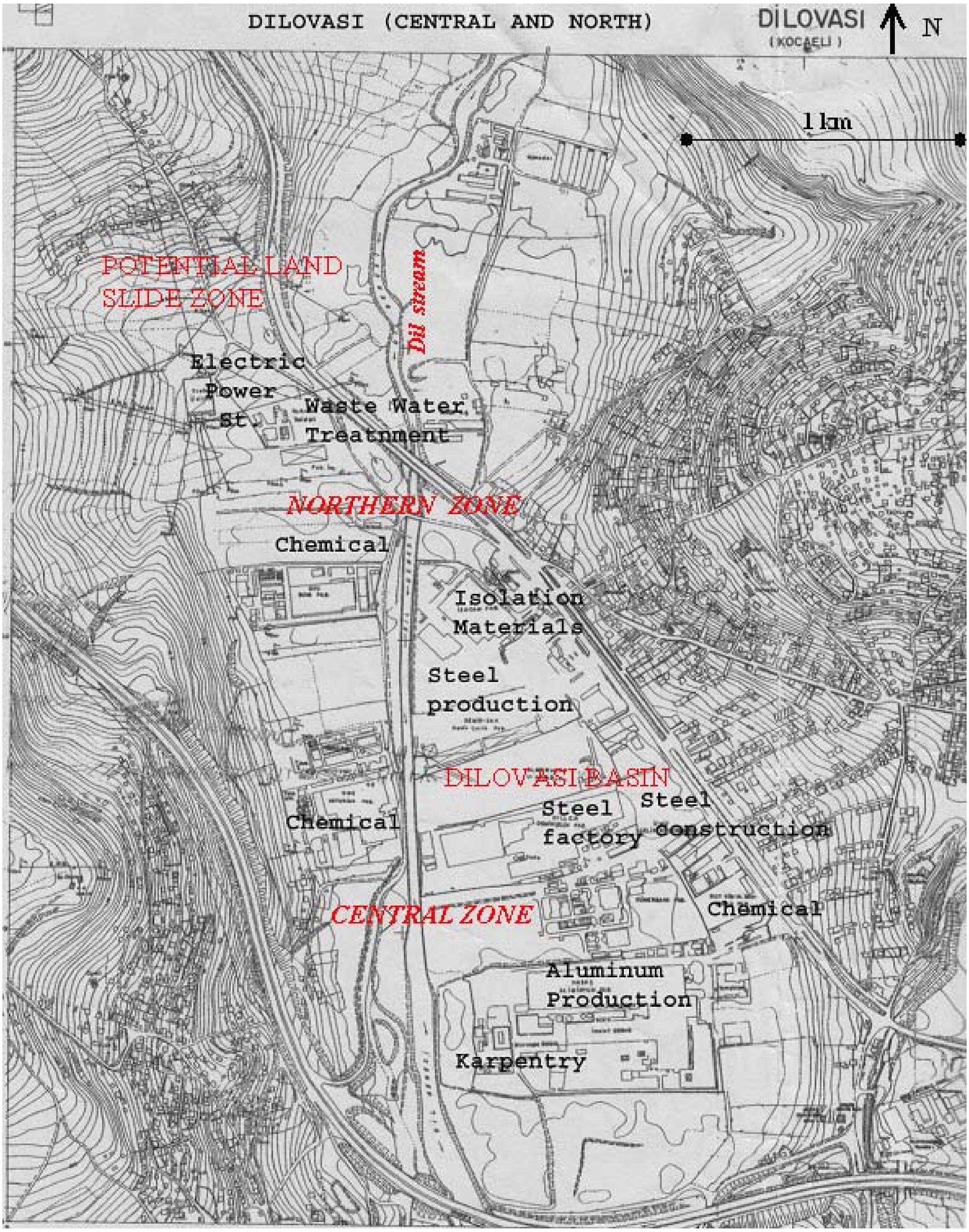


Figure 3.2.27. General map of the central Dilovası region.

This zone, which corresponds to the area between the D-100 (E-5) highway and the TEM, forms the Dilovası basin. Even though there does not exist adequate questionnaires returned from this area, site visits just after the 1999 Kocaeli earthquake revealed extensive damage to some of the reinforced concrete structures (Sumerbank-Basf). The general sectoral distribution vary from chemical, petrochemical to steel mills.

Figure 3.2.28. The solvent storage tanks and the R.C. chimney in Central Dilovası , from south.

Generally R/C chimneys have more resistance to earthquake loads compared to ones made of brick or steel. However once a damage occurs it is more expensive to repair a R.C. chimney compared to the other types.

Figure 3.2.29. The 175 meters tall R/C chimney of a paint production factory in central Dilovası.

Figure 3.2.30. Storage tanks of a paint production factory.

Figure 3.2.31. Tall and slender steel storage tanks of the paint production factory.

Figure 3.2.32. Steel mills in central Dilovası , (from north.)

The erection of steel plants usually involves large scale construction sites. Considering the physical weight and height of these plants, special attention is required to assess the quality of the subsoil and the type of the foundations used. Even minor damage to the process plant or electronic controlling equipment may result in total interruption of production in a modern fully automated rolling mill controlled by a process computer.

Earthquake induced damage may include, collapse of steel-framed structures, storage rack collapses, and severe equipment and nonstructural damage.

Figure 3.2.33. Arial view of the central zone (from north-east).

Figure 3.2.34. The 360 GWh/year capacity power generation-unit of Ova Electric Company fuel cource: N.G.

Figure 3.2.35. Electrical transmission and control equipments of Ova Electric company.

Figure 3.2.36. Vertical storage tanks of Marshall paint factory.

Major facilities operating in the region are heavy industrial such as, steel, chemical processing, and beverages. Critical non building components are fossil fuel or Co-Generation electric power generators, electric power transmission and distribution and substations and storage tanks.

Figure 3.2.37. The iron and steel plant of the Diler company producing carbon steel bars in central Dilovası.

Figure 3.2.38. Vertical storage tanks in southern Dilovası. Foundation anchorages are susceptible to damage due to rocking motion during an earthquake.

Figure 3.2.39. Crude oil transmission lines in central Dilovasi

Figure 3.2.40. Vertical storage tanks in central Dilovasi

Some essential companies operating in the region can be listed as, Ova Elektrik, NASAS, BASF; Demircelik, Lever, Dyo, Marshall, Solventas and Söylemez Döküm.

<u>Zone 3: (The northern zone)</u>

This zone corresponds to the north-west of Dilovası. The area is reported to be susceptible to landsliding.

During recent earthquakes some of the reinforced concrete structures in the zone have received various degrees of damage (e.g. Porland ceramic). Some of the silos in petrochemical industry experienced movements during 1999 Kocaeli Earthquake. The distance of these facilities were up to 50/25 km distance to epicenter/fault and estimated PGA at the site was 0.25g for soft alluvial deposits.

Figure 3.2.41. A view of Dilovasi from north

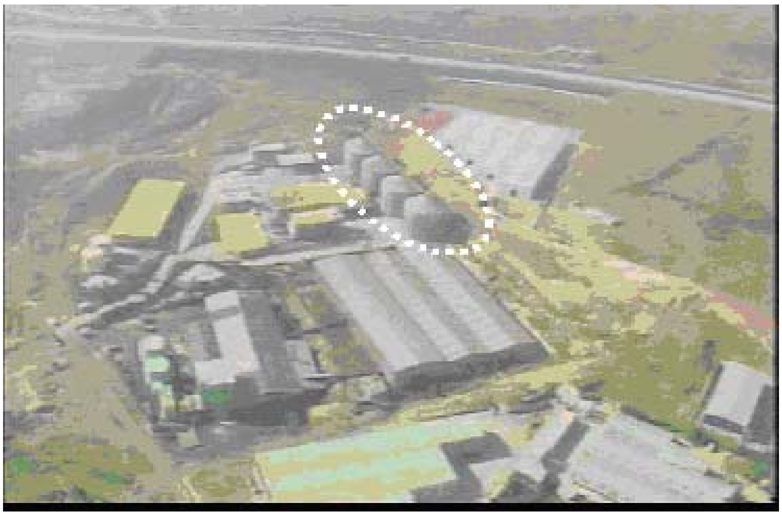


Figure 3.2.42. Silos in northern Dilovasi

The silos of a production facility are shown in detail below. In addition, cracking of reinforced concrete elements, silo, movement, damage to pipe joints, steel tank roof damage (sloshing) were observed.

Figure 3.2.43. Silos in northern Dilovasi

Figure 3.2.44. The storage tanks in northern Dilovasi

The non-building structural components can be listed as storage tanks, silos and power stations. Transportation, metal forming, power generation, chemical and petro chemical sectors and components are the main items to be considered in this region. The companies operating in the region are, Gözde Tarım, Ceyhan Nakliyat, Anadolu Metal, Merbolin Boya

(A2) Gebze and Vicinity

The locality, which is termed as “A2”, corresponds to the district of Gebze and its vicinity. Distribution of industrial facilities in and vicinity of Gebze (NW of Gebze), Şekerpınar (North of Gebze) and Darıca – Bayramoğlu (SW of Gebze) indicate unhomogenity. There does not exist a certain standard for the identification of structures. However a mixture of old and new facilities are located along the E-5 highway. There also exist some individual facilities spread to the southern regions of Gebze. The administration buildings of these facilities are generally made of two story reinforced concrete structures. On the other hand relatively large production units are built of either prefabricated or steel construction. Generally, large, organized, new and modern complexes are located to the north of the E-5 highway (along TEM) forming industrial parks. There also exits a number of individual facilities spread along the E-100 highway close to the city center, and some other at some specific locations such as, Darıca and Bayramoglu, along the coastal line (Figure 3.2.45).

Along the TEM (The northern bound)

- The Tuzla Organized Leather Industrial Zone, Industrial Park (1)
- The Tuzla Organized Leather Chemical Industrial Zone, Industrial Park (2)
- Gebze Organized Industrial Zone (GOSB) Industrial Park (3)
- Automotive (Honda –Isuzu) (No data available)

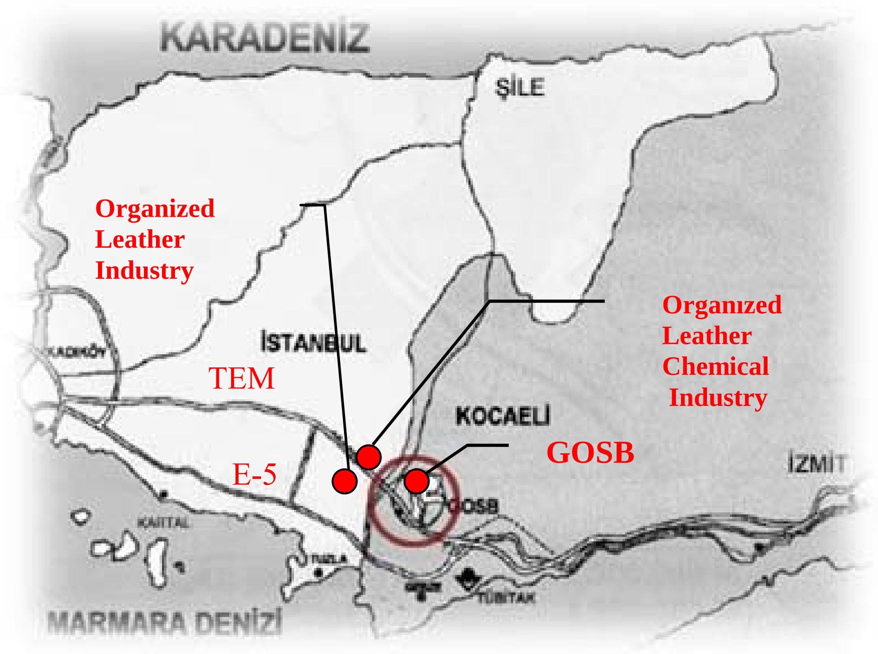


Figure 3.2.45. Industrial Parks in the vicinity of Gebze.

The locations of the essential industrial parks in the region are represented by three sub localities (in red) in Figure 3.2.45. These sub-localities (to the northeast of Tuzla) correspond to the zones of, (1) Organized Leather Industrial zone, (2) Organized Leather Chemical Industrial zone, and the (3) Gebze Organized Industrial zone. General distribution of these facilities will be shown in the following sections.

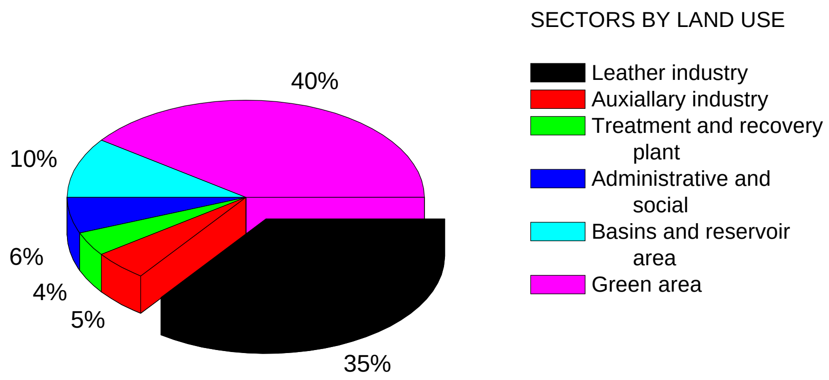
The Tuzla Organized Leather Industrial Zone (GOSB) Industrial Park (1)

The complex is set up next to the TEM, on an area of approximately 7.0 million square meters, in the county of Tuzla, at a distance of 6.5 km to the north of E-5 highway. Even though the area is within the border of Tuzla district, due its proximity to other industrial complexes in the vicinity of Gebze, it is assumed to be included in the neighboring district (Figure 3.2.46).

Figure 3.2.46. General Layout of the Tuzla Organized Leather Industrial Zone.

Figure 3.2.47. Typical prefabricated warehouse unit in Tuzla Organized Leather Free Zone.

The complex is composed of several sub complexes and utilities and the land use distribution of the Tuzla Organized Leather Industrial Zone can be given as in Figure 3.2.48.



Sectoral distribution by land use (Tuzla Organized Leather Industrial Zone)

Figure 3.2.48. Sectoral distribution by land use (Tuzla Organized Leather Industrial)

There exist three basins with two of them being completed. The most important component in the area is the 36000 cubic meters/day capacity treatment plant which is reported to be the largest and most efficient plant among the plants treating the waste water of the leather industries in the world. The total length of the water pipe network extends to a distance of 40 km.

Figure 3.2.49. The waste water treatment plant, aerial view.

It is reported to be that, during the 1999 Kocaeli earthquake some of the water treatment plants in Izmit, suffered from minor damage. Similarly for a future earthquake, equipment and plant components are as well, subject to damage depending on the intensity of ground shake at the site and also local waste water systems may be damaged particularly in areas those being subjected to ground settlement. This is an issue, which needs to be checked considering the local soil conditions.

The Istanbul Leather Industrial Free Zone

The Istanbul Leather Free Zone is founded on an area of 114,000 m^2 as a “Specialized Free Zone”, adjacent to the Istanbul Organized Leather Industry Zone, in Tuzla district. The total trade volume of nearly 100,000,000 USD realized in 1995 in the zone was increased up to 125% in the first ten months of 1996 and constantly increasing since then. The zone is the first free zone in Istanbul having open and closed areas and production activities with high development potential.

Figure 3.2.50. Building structures in the Istanbul leather free zone, aerial photo.

The subjects of activities of the zone is composed (1) production (ready-made clothes, textile goods and clothing) and (2) commercial and service such as, machinery and parts related to production, stock, exhibition, and sale, activities.

Majority of the buildings in the area are 2-4 story reinforced concrete or prefabricated structures. Since the structural elements are comparably new and of good quality, damage to vibration sensitive equipments or fire induced damage to might be considered rather than direct damage to structural elements.

Tuzla Organized Leather Chemical Industrial Zone (Industrial Park 2)

The complex has just been set up adjacent to the leather industrial zone with an intention of providing chemicals required for the leather processing.

Typical building structures are similar to the ones in the leather, as shown in Figure 3.2.51 and Figure 3.2.52.

Figure 3.2.51. Typical building structures in Tuzla Organized Leather Chemical Industrial Zone

Figure 3.2.52. New constructions in Tuzla Organized Leather Chemical Industrial Zone

The Gebze Organized Industrial Zone, GOSB (Industrial Park 3)

The Gebze Organized Industrial Zone (GOSB) is founded on a 7.3 million square meters area, located to the north of the TEM as shown in the general layout given in Figure 3.2.53.

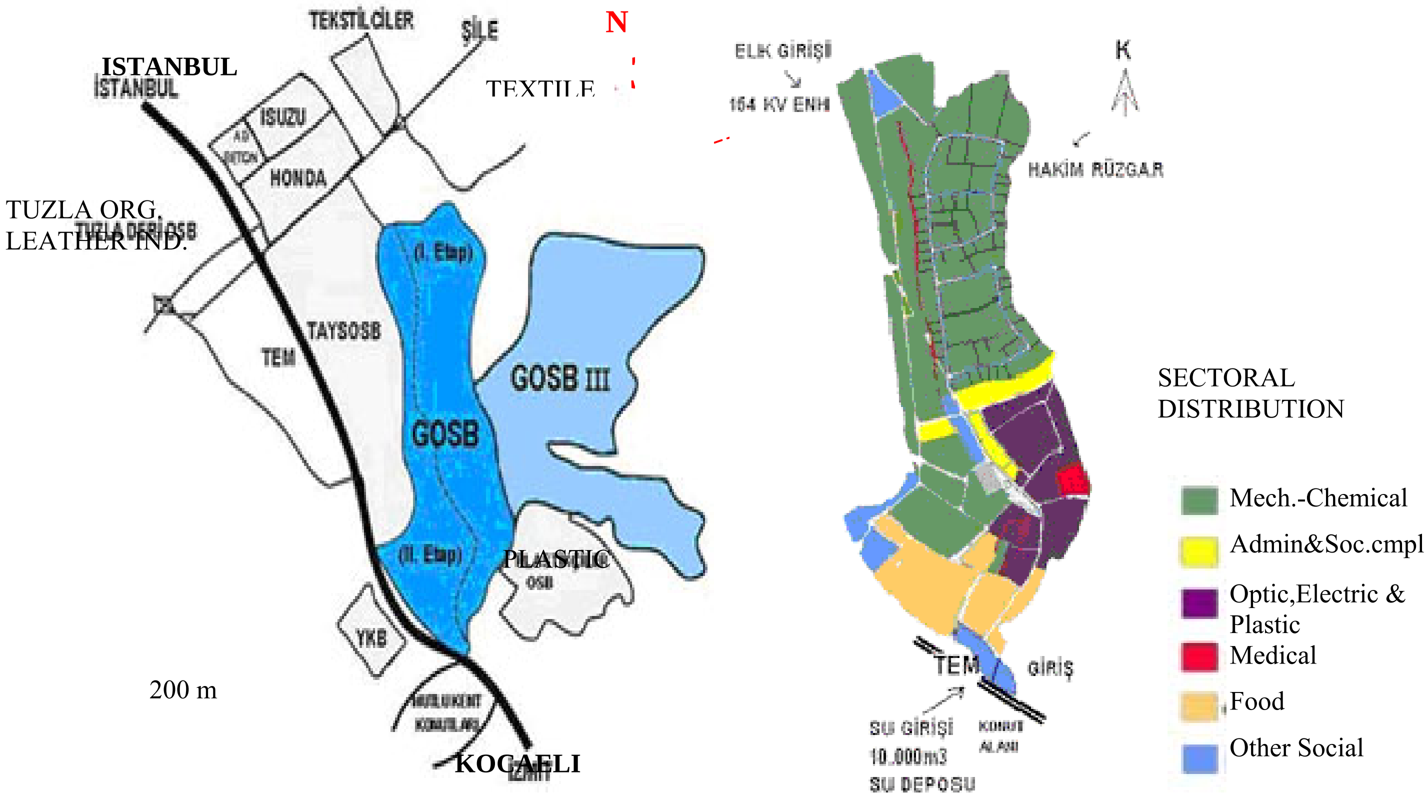


Figure 3.2.53. General layout of the Gebze Organized Industrial Zone and the land use distribution on sectoral basis.

Figure 3.2.54. Aerial view of the Gebze Organized Industrial Zone (GOSB)

Being similar to the other industrial parks, a major earthquake can cause only limited material damage but may result in a serious interruption of business if the plant is shut down at the time. For example, even minor damage to the process plant or electronic controlling a modern fully automated equipments controlled by a process computer and may result in total interruption of production.

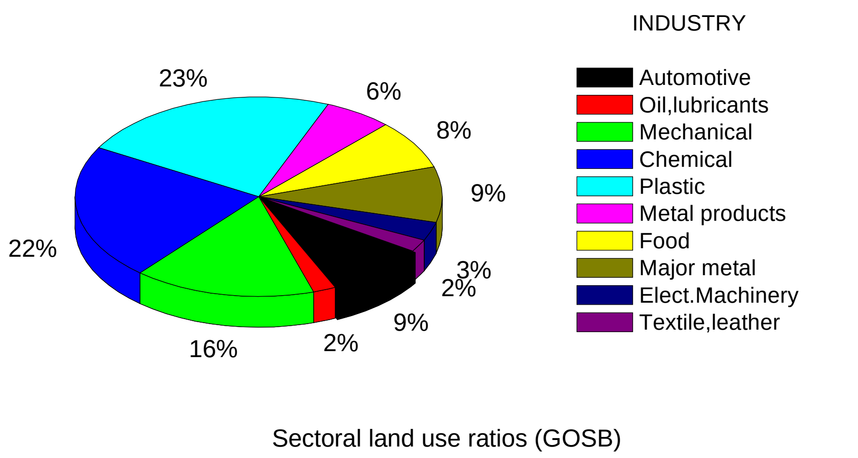


Figure 3.2.55. Sectoral land use ratios for GOSB.

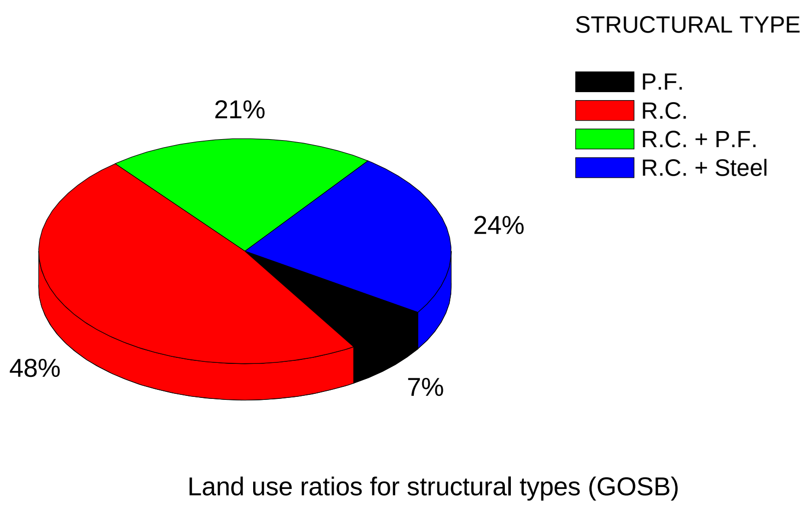


Figure 3.2.56. Land use ratios for structural types in GOSB.

Along The E-5 Highway

From Çayırova (west) to Gebze Exit (east), along a distance of 8 km, there exits a number of industrial facilities distributed at both sides of the highway. The sectoral distribution of the facilities in this region is given in Figure 3.2.57.

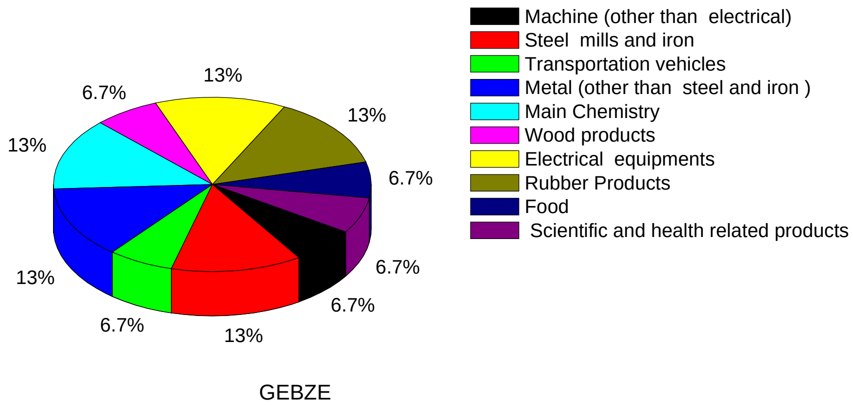


Figure 3.2.57. Sectoral distribution of the industrial facilities located along the E-5 highway in Gebze.

As it can be seen from the pie chart in Figure 3.2.57, metal forming (steel and other metals) sectors participate in considerable amounts (nearly 30 %) to the overall production capacity of the region. More data are required for a better representation of the sectoral distribution in the region.

Considering Gebze and Dilovası as a single region, the sectoral distribution pie chart provided in Figure 3.2.58 can be prepared.

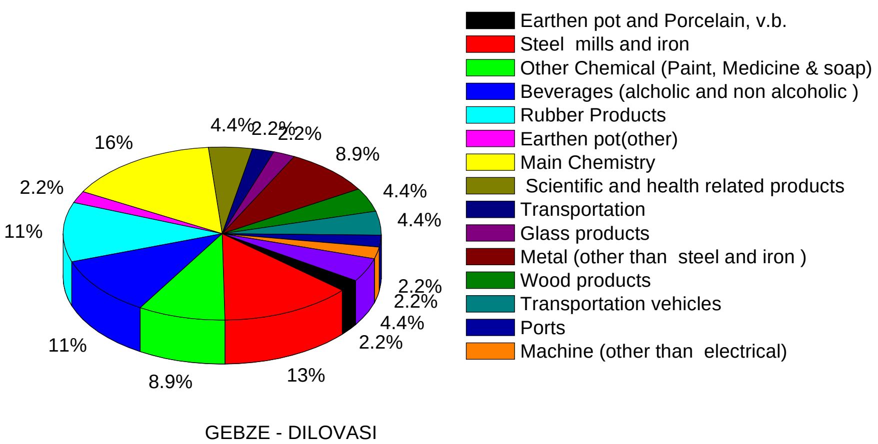
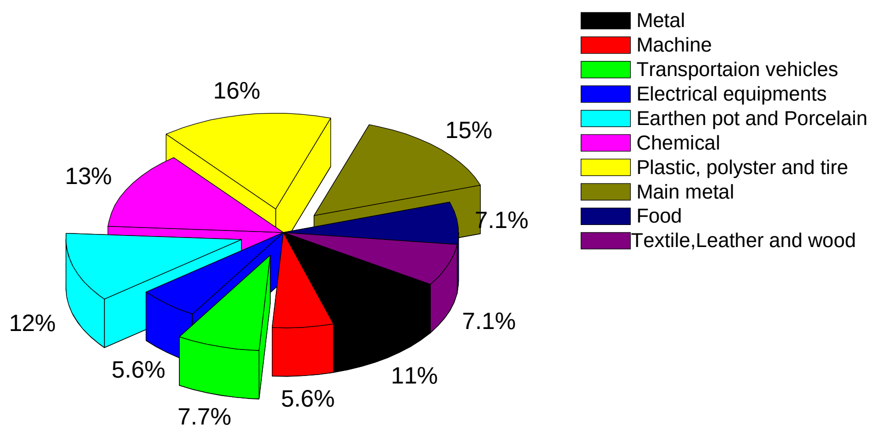
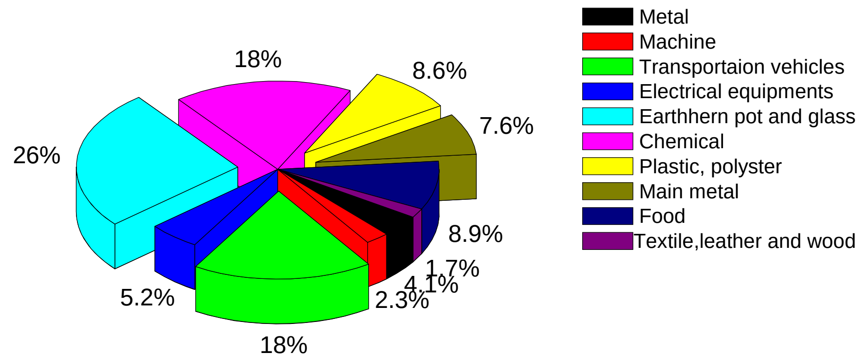


Figure 3.2.58. Sectoral distribution for Gebze and Dilovası (considered together).

Pie charts are also prepared for Gebze and Dilovasi regions by referring to the data provided from the Trade Union of Gebze (GTO) and presented below.



Sectoral ratios by quantity.
(Excluding the industrial facilities with total values below 100 000 USD)
(for Gebze and Dilovasi regions)



Sectoral ratios by total value.
(Excluding the industrial facilities with total values below 100 000 USD)
(for Gebze and Dilovasi regions)

Figure 3.2.59. Sectoral distributions with respect to the total value or total amount

From the pie charts shown Figure 3.2.59, it can be seen that sectoral distributions with respect to the total value or total amount differ in considerable amounts (upto 200%) especially in the sectors of , transportation, plastic, metal and earthern pot and glass products. When comparing the above pie charts to the ones provided from the Municipality (in the previous section) of Dilovasi and personal contacts, an appreciable amount of deviation can be observed. This is an indication that a reliable sectoral distribution is very sensitive to the total number of data gathered , and the results of a limited data might not be a good representation of the whole region.
Administrative buildings are standard 2-3 story reinforced concrete structures and the production plants -units have large (typically 50x150 m) plan dimensions. The critical

equipment consists of power distribution systems, engine-generators, UPS and co-generation systems. Some typical facilities are given in Figure 3.2.60 through Figure 3.2.63.

Figure 3.2.60. An industrial facility for drying wood shavings.

Figure 3.2.61. Typical production unit of a new construction on the E-5 Highway near the city center of Gebze.

Figure 3.2.62. An industrial park consisting of small scale industrial facilities taking place in the automotive sector in central Gebze.

Figure 3.2.63. Typical Prefabricated (PF) building structure in Gebze, (under construction).

There also exists some chemical processing industrial facilities as illustrated in Figure.3.2.64 and Figure.3.2.65.

Figure.3.2.64 The chemical plant of the Bayer company

Figure.3.2.65. The storage tanks of the Bayer company chemical plant, located on the E-5 Highway, in Gebze.

Other individual facilities in the coastal region of Gebze and Bayramoglu are illustrated in Figure 3.2.66 and Figure 3.2.68

Figure 3.2.66. The cement plant in Darıca is being operated by Lafarge Aslan Cement and handles cement and coal as cargo materials.

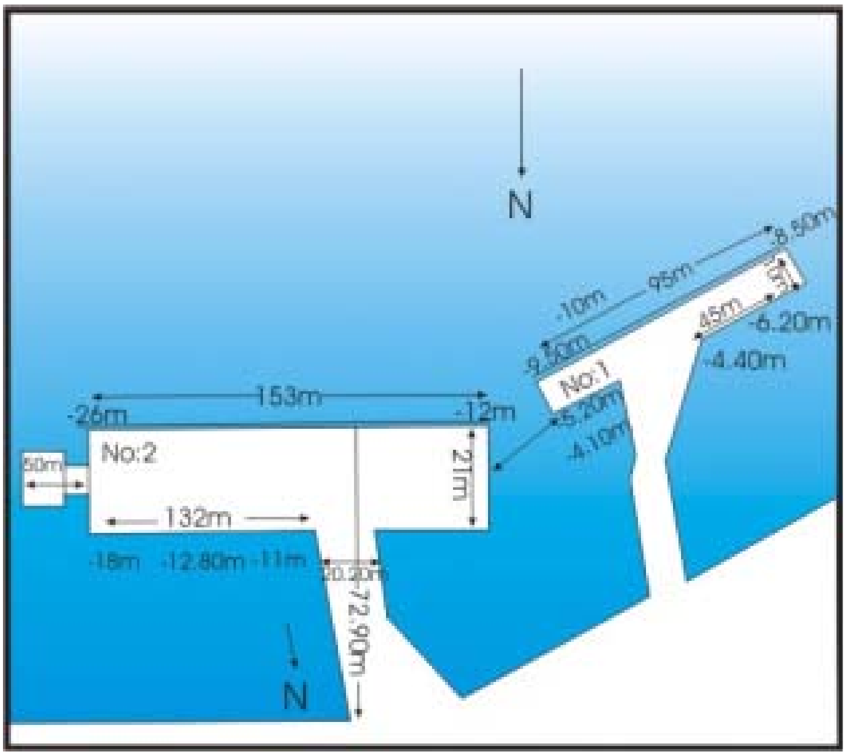


Figure 3.2.67. Schematic representation of the port of Lafarge Aslan Cement factory

Figure 3.2.68. Glass production factory (Bayramoğlu- Şişe Cam factory)

(A3) Tuzla and Vicinity (Water Front Structures, Dockyard and the Waste Water Treatment Plant)

The locality, “A3”, corresponds to the coastal regions of the two neighbor districts of, Tuzla and Kaynarca. The region is occupied by water front structures such as, dockyards, ports and harbors, which are believed to be susceptible to submarine landslides or ground settlement due to liquefaction.
General view of the water front structures in Tuzla is seen in Figure 3.2.69 through Figure 3.2.73.

Figure 3.2.69. General view of the Tuzla Dockyard, (from north)

Figure 3.2.70. Aerial view of Tuzla Dockyard (from south)

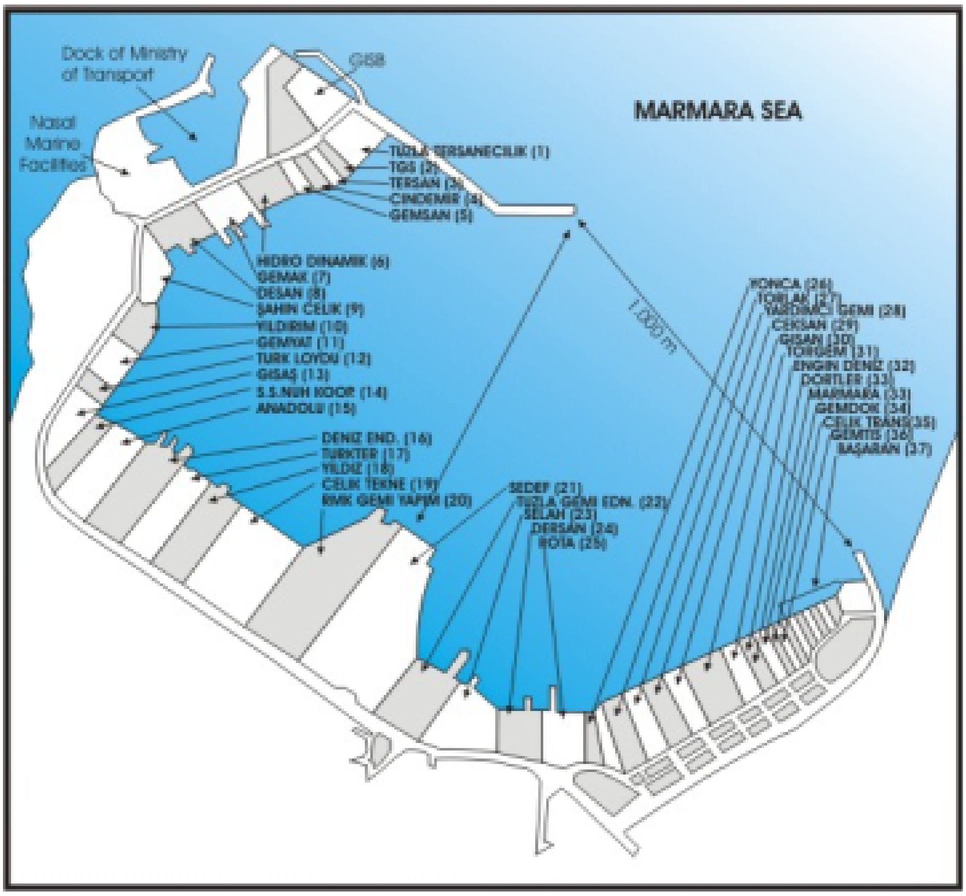


Figure 3.2.71. General layout of companies operating in the Tuzla Dockyard

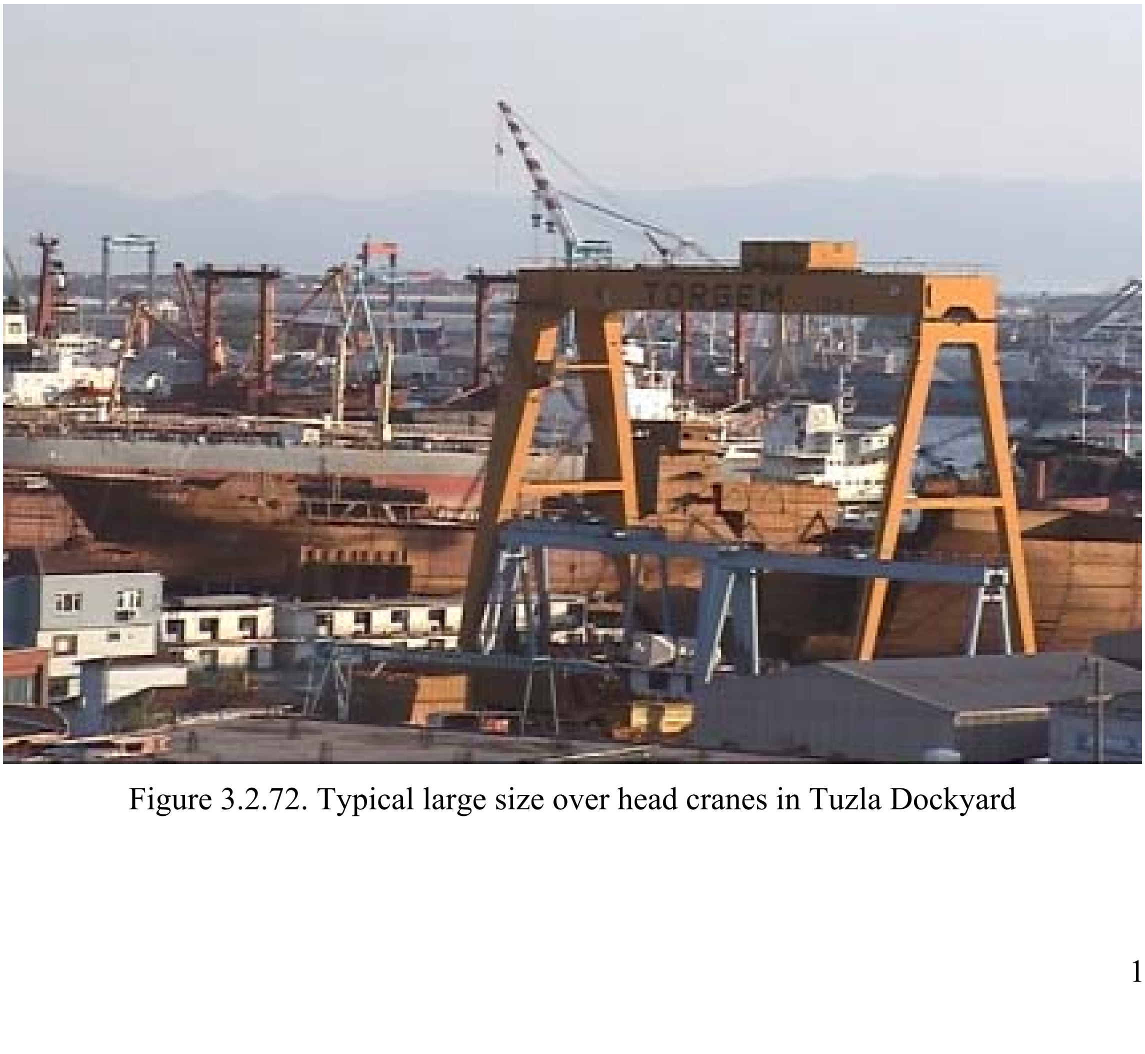


Figure 3.2.72. Typical large size over head cranes in Tuzla Dockyard

Figure 3.2.73. General view of the over head cranes in Tuzla Dockyard, (from west).

Cranes and winches are the typical non-building structural components in the region and these structures are more likely to be subjected to rocking motion during strong earthquakes. During the 1999, Kocaeli Earthquake, the quay walls of the Tuzla Port moved about 40 cm horizontally and the backfill settled about 10 cm. Damage may be expected in a major earthquake. Berths can be damaged due to ground subsidence.

Figure 3.2.74. A large crane in Tuzla Dockyard

Rigid and slender structures such as overhead conveyor equipment or cranes on weak foundations may suffer damage with loss of foundations (Figure 3.2.74).

<u>Kaynarca:</u>

The district of Kaynarca is only a couple of km's to the west of Tuzla and similar conditions also apply to this zone. Larger size cranes exist in military zones.

Fig. 3.2.75. Huge over head cranes in the military zone, in Kaynarca

Figure 3.2.76. General layout of the water front structures in the military zone in Kaynarca, from north-west.

The Waste Water Treatment Plant:

Another critical facility in the region, which is being operated by the Istanbul Municipality is the waste water treatment plant. The facility is founded on a highly liquefiable area. Since rigid and heavy structures founded on very weak soils with potential liquefaction may undergo rocking motion during strong earthquakes, the region needs to be analyzed in detail.

Figure 3.2.77. General view of the waste water treatment plant site in Tuzla, aerial photo.

Figure 3.2.78. Closer view of the waste water treatment tanks.

(A4) Port of Haydarpasa (Customs Area) and Moda (Sea Port)

The port of Haydarpasa which is being operated by the General Directorate of Turkish Sate Railways (TCDD) is situated on the Anatolian side of Bosphorus in Istanbul. It has a great importance being a gateway to the world as the biggest container port in Marmara Region. Haydarpasa Port handles about 4 million tons of cargo and 2 million tons of container per year. Port facilities include two 40 ton capacity container cranes and numerous shore and yard cranes of various capacity.

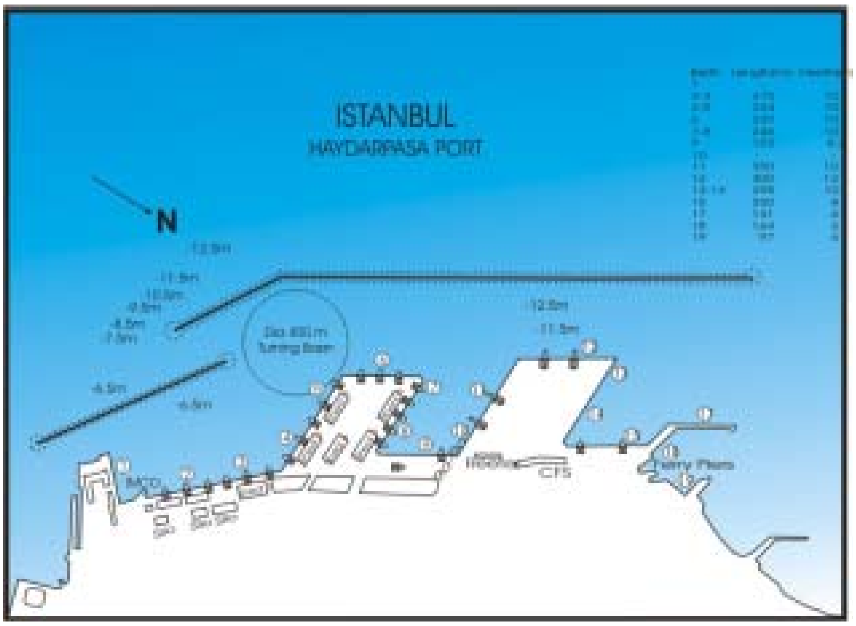


Figure 3.2.79. General layout of the port of Haydarpasa

The port has two breakwaters so as to protect the vessels form all kinds of effects caused by the sea. There exists various types of cargo handling equipments such as, floating cranes of 250 tons cap, shore and yard cranes of 3 to 35 tons capacity, mobile cranes , general cargo forklifts, loaders, tractors, trailers, trailers, weigh-bridges and rail ferries. The open and covered storage are as 313.047 sq.m. and 21.043 sq.m , respectively.The space for container terminal is nearly 100.000 sqm and the holding capacity of the container terminal is 6.000 TEU (both full and empty). The annual capacity is 144.000 TEU/year. There are two areas hired outside the port for stacking the empty containers. A container freight station of 3.600 sq.m. is available behind the container quay. The Ro-Ro terminals can accommodate 360 ships per year, and can handle 410.000 tons/year of Ro-Ro cargo, 65.000 trucks (incoming-outgoing), and 60.000 cars/year. Berths serve the dry bulk traffic.

The aerial photo of the Haydarpasa port and custom area is shown in Figure 3.2.80 and Figure 3.2.81.

Figure 3.2.80. General view of the Haydarpasa customs area, an aerial photo.

Figure 3.2.81. Haydarpasa customs area

The aerial view the Moda sea Port is shown Figure 3.2.82.

Figure 3.2.82. Moda Sea Port (Marina).

(E1) AMBARLI

The Ambarlı port which is located 34 km away from Istanbul, is a critical water front industrial complex that encompasses a power plant , port, LNG and LPG facilities. Ambarlı also serves as the main terminal of LNG pipelines traverse Marmara Sea between Ambarlı and Pendik. Similar conditions for high earthquake hazard also apply to the structures in the port area. The port is divided into two regions.

Figure 3.2.83. General view of the Ambarli Port, Regions 1 and 2

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Region No.1 consists of oil platforms, jetties and mooring buoys and the companies are:
Cekisan (BP Amoco/ Mobil/Shell) Jetty, Offshore Platform and Mooring Buoys,
BP Amoco Mooring buoys,
Aygaz Offshore Platform,
TEAS/Petrol Ofisi Platform and Mooring

Figure 3.2.84. Aerial view of the Region 1 (Oil platforms and Buoys) of the Ambarli Port

Region No.2 (Ambarli New Port) is located to the west of the oil terminals and consists of privately owned dry, container terminals.

Figure 3.2.85. General view of Region 2 of the Ambarlı port.

Some of the cargo equipments are shown below.

Figure 3.2.86. The winches, containers and cargo equipments in Region 2

Figure 3.2.87. Typical containers , mobile winches and cargo equipments in Region 2

The companies operating in the region are shown in the general layout Figure 3.2.88.

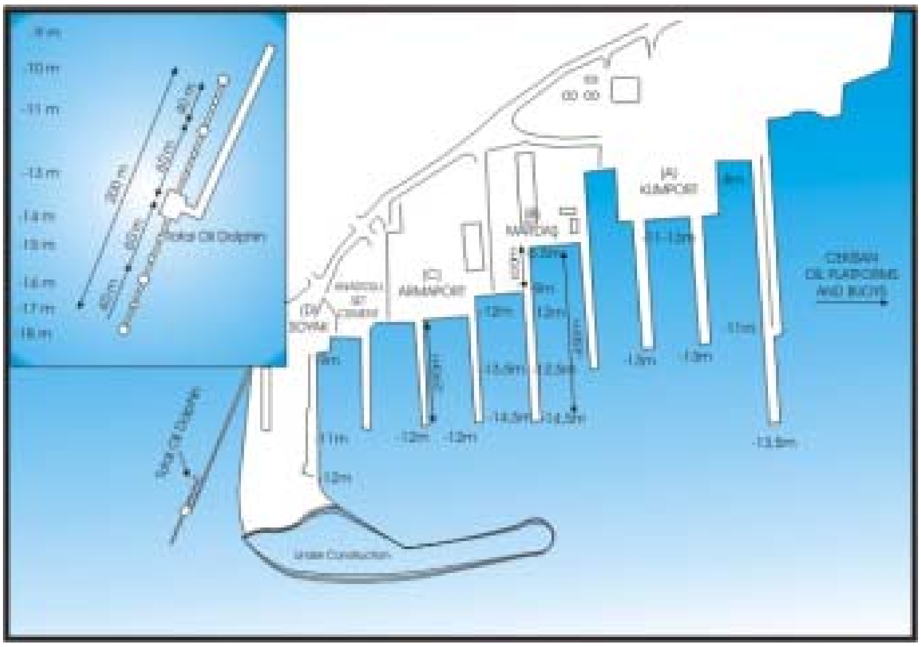

Figure 3.2.88. General layout of the companies in Region 2 of the Ambarli Port

The facilities in Region No.2 are:

Kumport is being operated by Kumport Liman Isletmesi San. Tic. A.S and consists of 16 berths. Main activity is to handle multipurpose non hazardous cargoes. There exit open and covered storage areas of 375.000 sq.m. and 4.500 sq.m., respectively. General cargo capacity is 2.000tons/day, and for steel products 10.000tons/day, rulos paper 1.500tons/day and Ro-Ro 50 TIR/hr. Container cranes, mobile cranes ,container stacker trailers , forklifts are the basic cargo handling equipments.

Akcansa Cement Pier is being operated by Akcansa Cimento Sanayi ve Ticaret A.S. There exists a 1.000 sq.m. closed storage area and 18.000sq.m. covered storage area that is custom bonded. Scrap, pig-iron, pipes, paper, wood products, timber, coal, chemicals, general cargo, palletized cargo, bulk, liquid and solid are the basic types of cargo handled by the company. Loading and discharging capacity is 10.000 tons/day. Mobil Cranes, cat loaders are the basic cargo handling equipments.

Mardas handles iron-steel raw material, iron ore products , and is being operated by Mardas, Marmara Deniz Isletmeligi A.S. Types of cargo handled are, Scrap, Ferro alloys, Pig-iron, Rebars, Billets, Pipe, Paper, Wood products, Coal, Sugar, Cocoa, Cereals, Chemicals, General cargo, Palletized cargo, Bulk, Liquid and Solid and Container. Loading and discharging capacity is 10.000 tons/day and the basic cargo handling equipments are, cranes, scrap handlers, harbour cranes, grapples, wheel loaders and forklifts. There exist open and covered storage areas of 40.000 sq.m and 6.000 sq.m., respectively.

Ambarli Shipowners Port is being operated by Armatörler Liman Isletmeciligi Tic. San. A.S. Total port area is 128.000 sq.m and the container handling yard is 50.000sq.m.The warehouse storage area is 5.000sq.m. Basic cargo equipments are, container stackers, telescopic spreaders, fixed spreaders and forklifts.

Anadolu and Set Cement Pier is being operated by the Anadolu Cimentolari T.A.S.. Types of cargo handled are, bulk cement, trass (cement additive) coal and clinker. Cargo handling equipments are, pneumatic mobile cranes, loaders and forklifts. There exists a total storage area 36.000sq.m.

Soyak Port which is a general cargo, Ro-Ro and container port. is being operated by Soyak Port Liman Isletmeleri A.S. All kinds of goods from container to automobile, from cast goods to mixed commodities, are being loaded and unloaded with the appropriate equipment. Cargo handling equipments are, mobile cranes, tower cranes, stackers, forklifts, weigh-bridge, TIR low bed trailers and tractors. There exist, 2.750 sq.m. closed and 65.000sq.m. open custom bonded storage areas.

The water front structures in Ambarlı port are erected on very weak subsoil conditions. As in the cases of other water front structures in Dilovası (A1) and Tuzla (A3) damage potential increases due to the susceptible liquefaction.

(E2) Marmara Ereglisi and Vicinity

The locality of,E2, in Marmara Ereglisi is a concentrated location for a single/individual but very critical industrial facility, the Botas LNG Terminal, which is being operated by the Botas Petroleum Pipeline Corporation. The company holds monopoly in import, distribution, and sale of natural gas in Turkey and carries out various kinds of petroleum related activities such as exploration, drilling, production, transportation, storage and refining. For the purpose of providing crude oil and natural gas from abroad, the company constructs pipelines for petroleum, petroleum products, and natural gas within and outside of Turkey, to transport petroleum, petroleum products and natural gas through the pipelines and to purchase and sell the crude oil and natural gas transported in the pipelines. The import volume for natural gas has been increased to 4 Bcma.

The Liquefied Natural Gas (LNG) Import Terminal LNG import terminal was built in order to use for diversifying the natural gas supply sources. It also serves as a base load plant and a means of peak shaving when required.

The marine jetty is a 380m long piled structure with 73 steel piles. There are four breasting and six mooring dolphins.

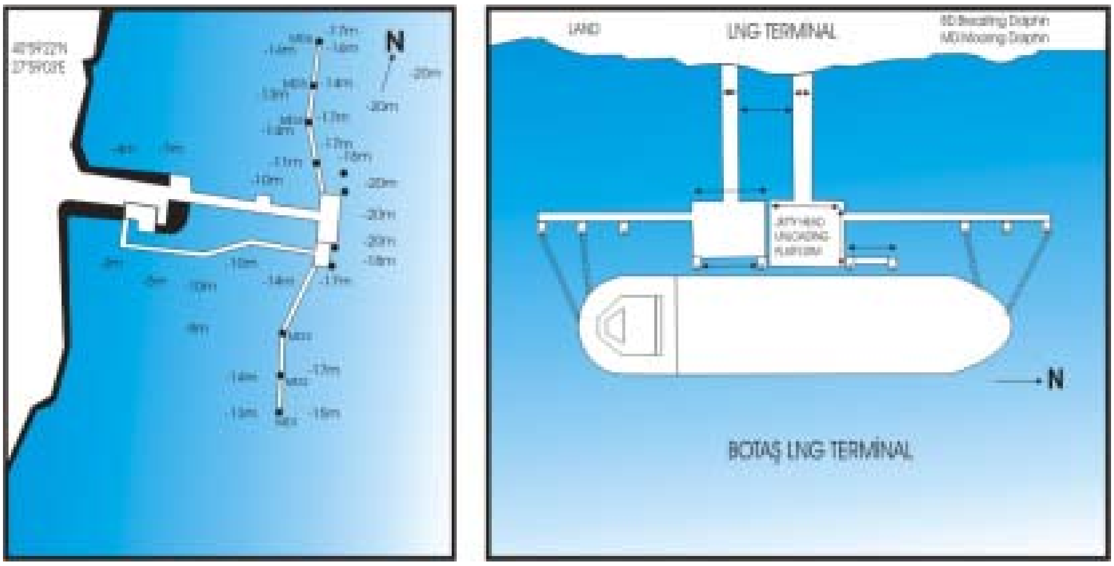

Figure 3.2.89. Schematic representation of the Marine Jetty and the Dolphins used for unloading

Figure 3.2.90. Aerial view of the marine jetty of the Botas terminal in Marmara Ereglisi .

The two main functions of the terminal are:

a. LNG ship unloading and storage.

b. LNG Vaporisation and natural gas send out the terminal is designed for an average natural gas send out rate of 6 billion Nm3/year. The terminal exported natural gas 4.5 billion Nm3 in 2001.

UNLOADING AND STORAGE: After the unloading arms have been connected, the LNG is sent to three storage tanks by the ship's pumps at a flow rate of 10.500 m3/hr. The storage tanks are of the "double containment self-supporting" type. Each tank is 39 m high and has a capacity of 85.000 m3. Tank bunds in the form of 70 cm. thick concrete walls are constructed vertically to surround each tank. Inner tank is made up of 9% nickel steel and outer tank is carbon steel. Three submerged, wheel mounted low pressure pumps are provided for each tank. A fourth pump wheel is included in the tank to accommodate a spare pump. Each tank LTD devices to avoid the stratification of LNG.

Figure 3.2.91. The LNG storage tanks and vaporized LNG distribution units.

LNG compression and regasification: is carried out at high pressure to avoid having to pressurize the gas produced which requires much more energy. The LNG is removed from the tanks by using submerged pumps which increase its pressure LNG is compressed by send out pumps located together in the high pressure pumping station. rated capacity of each of vaporizers is 228.000 Nm3/h of gas.

Gas sendout: automation metering and control systems: the basic functions of the control center located in the main control room era as follows: Indication of analog and digital variables.. In addition, all gas detection, UV/IR, HD, TD etc. throughout the terminal are displayed and deluge and halon systems are controlled in control room.

One of the two power stations operating in the vicinity of the Botas facility uses the vaporized LNG which is send out of the Botas storage terminal.

Figure 3.2.92. LNG Power Station No:1 in Marmara Ereglisi which is being operated by the company ENRON..

Figure 3.2.93. The electrical equipments of the Power station No:1

There exists another independent facility in the region which is consisting of LPG storage tanks. Even though the facility is closely spaced to Botas terminal, it operated as an independent facility and does not have a direct connection to the previously mentioned units.

Figure 3.2.94. The LPG storage tanks in Marmara Ereglisi, near Botas.

Figure 3.2.95. A steel structure under construction near Botas company in Marmara Ereglisi.

(E3) Çerkezkoy and Vicinity

Çerkezkoy is located 50 km to the north of the fault line and can be considered to be the heart of the light manufacturing industry. Industrial facilities in this region are generally large textile complexes as well as medium size industrial parks (Figure 3.2.96 and Figure 3.2.97). Structural types are either precast concrete frame (PF) or steel with masonry infill.

Figure 3.2.96. A large textile complex in Cerkezkoy.

Figure 3.2.97. A complex near Cerkezkoy

Precast concrete frame (PF) have become a popular construction type for warehouse and low cost production facilities. These structures have the potential to perform poorly, due to lack of seismic detailing at the beam coloumn connections.

Typical precast reinforced frame structural type (P.F.) is widely used in Cerkezkoy as indicated in Figure 3.2.98 through Figure 3.2.102.

Figure 3.2.98. Construction of a prefabricated structure on a wide area in Cerkezkoy.

Figure 3.2.99. Typical construction type for the industrial facilities near Cerkezkoy

Figure 3.2.100. A complex near Cerkezkoy

Figure 3.2.101 A typical production/warehouse unit near Catalca

Figure 3.2.102. A typical industrial park consisting of small to medium size P.F. facilities near Catalca

(E4) Ikitelli and Other Industrial Locations (Bahcesehir,Hadimkoy, Silivri)

The general characteristics of the industrial facilities at İkitelli, Bahçeşehir, Hadımkoy and Silivri can be illustrated by Figure 3.2.103 through Figure 3.2.107.

Figure 3.2.103. Aeriel view of the industrial park in Ikitelli.

Figure 3.2.104. Various types of building structures in the vicinity of Ikitelli industrial park.

Figure 3.2.105. An industrial park near Bahcesehir

Figure 3.2.106. An individual oil factory in Silivri.

Figure 3.2.107. A large cement factory in Buyukcekmece

REFERENCES

www.cerrahogullari.com.tr

www.rms.com/publication/Turkey_Event.pdf