TURKEY

MARMARA EARTHQUAKE ASSESSMENT

September 14, 1999

Turkey Country Office
The World Bank

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Preface

On August 17, the Marmara Region of Turkey was hit by a massive earthquake. The World Bank was invited by the Government to help prepare an assessment of the cost of reconstruction and the impact of the earthquake on the economy. Two World Bank teams were mobilized very rapidly to assist the Government in this effort.

The Marmara Earthquake Emergency Recovery team began work on August 24 and completed an earthquake damage assessment. The team was comprised of Piotr Wilczynski (team leader, ECSSD), Nedret Durutan (ECCTR), Catherine Stevens (ECSSD), Christophe Pusch (ECSSD), Alcira Kreimer (TWURD), Richard Lacroix (ECSSD), Ralf Schwimmbeck (EMTOG), Dejan Ostojic (ECSEG), Anders Halldin (ECSSD), Eugene Gurenko (ECSIN), Amy Evans (ECSSD), Michael Mertaugh (ECSHD), Betty Hanan (ECSHD), Richard Andrews (Consultant), and Sven-Ake Blomberg (Consultant).

The second team began work on September 1 and completed an earthquake economic assessment and synthesized the two reports. The team was comprised of James Parks (Team Leader, ECCTR), Ismail Arslan (Deputy Team Leader, ECCTR), Abebe Aemro Selassie (IMF), Mark Sundberg (ECSPE), Jeanine Braithwaite (ECSPE), Tunc Uyanik (ECSFP), Nevin Turk (IFC), Insan Tunali (Consultant), Mediha Agar (ECCTR) and Pinar Baydar (ECCTR).

Both teams completed their work on September 10. This report, coordinated by James Parks, presents their findings. The report has been prepared under the overall guidance of Ajay Chhibber, Country Director.

The World Bank teams worked very closely with government agencies, and consulted widely with the private sector, non-governmental organizations, universities, other international agencies. The teams would like to thank the Undersecretariat of Treasury for coordinating their work.

The findings will need updating as more information becomes available. They represents our best estimates and conclusions at this point and are made available to help Government formulate an overall and comprehensive approach to the reconstruction and recovery from the earthquake.

World Bank
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Turkey: Marmara Earthquake Assessment

A. Executive Summary

1. On August 17, 1999 an earthquake measuring 7.4 on the Richter scale at 3:00 am. devastated the Marmara region of Turkey. Over 15,000 lives have been lost and there is extensive damage to Turkey's industrial heartland. As the region digs out of the rubble, it is clear that a major reconstruction effort and recovery plan is needed. International support for Turkey for the immediate relief effort has been rapid and generous. As Turkey looks ahead to rehabilitation and reconstruction, substantial international financing is needed. This preliminary assessment outlines the likely impact of the earthquake on the economy and the cost of reconstruction and recovery. It also highlights the key issues that need to be addressed to reduce the costs of future natural disasters in the country.

2. **Methodological Approach.** In assessing the impact of the Marmara earthquake on the Turkish economy, the Bank's teams have looked at three channels: (i) direct costs, (ii) indirect costs, and (iii) secondary effects. Direct costs refer to the physical damage to capital assets and inventories which can be attributed to the actual impact of the disaster. Indirect costs refer to flow effects including output losses and foregone earnings as well as the cost of emergency relief efforts. Secondary effects concern the short and medium-term impact of the disaster on overall economic performance such as the implications for the fiscal accounts and the balance of payments. Secondary effects also include the influence on the incidence of poverty as well as shifts in government policy to respond to the impact of the disaster on the economy including macroeconomic balances and inflation. While important, the direct costs do not tell the whole story about the full impact of natural disasters and say little about the underlying factors which may exacerbate or minimize the economic effects such as the structure of the economy or the quality of the Government policy response. Therefore, it is not possible to measure the impact of natural disasters in terms of a single financial figure.[1]

3 **Caveats.** In interpreting the teams' findings, it is essential to keep in mind two factors. First, given the scope of the earthquake and the need to prepare a rapid assessment, the teams were not able to focus in detail on the impact on all sectors of the economy nor could they consult with the entire range of public and private organizations. Therefore, there may be some gaps in the coverage of the assessment. Furthermore, the data available in the aftermath of the earthquake are preliminary and incomplete. Many of the key statistics continue to change daily. There are also a number of important inconsistencies in the data. Under these conditions, the teams were obliged to make a number of critical assumptions concerning key parameters which affect the results. Where relevant, these assumptions are made explicit in the report and further details are given in the Annex. For many key indicators, the teams have concentrated more on establishing reasonable ranges than on determining point estimates. In addition, the teams have identified several important areas for follow-up survey and analytical work.

[1] For a more detailed presentation of this methodological approach, see "The Economic Impact of Natural Disasters in the Philippines", Charlotte Benson, OECD Working Paper 99, June 1997.

4. **Key Findings.** The estimated costs of the earthquake are summarized in the table below In terms of direct costs, it is very difficult to estimate the total wealth lost at this stage given the limited information gathered to date. In particular, detailed survey data of capital and inventory losses in the housing and enterprise sectors are not yet available. On the basis of the partial data available (see para. 6), the Bank team estimates a range for the wealth loss of US$3-6.5 billion. (1.5 percent-3.3 percent of GNP). In terms of indirect costs, the Bank team estimates that the earthquake will reduce GNP in 1999 by 0.6 percent-1.0 percent, equivalent to US$1.2-2 billion. This estimate assumes that at least part of the output loss in the affected region will be made up by increased production elsewhere in the economy. In the year 2000, GNP growth is expected to exceed baseline forecasts by some 1 percent of GNP due primarily to reconstruction activity. This optimistic scenario for 2000 is predicated on substantial external financing for reconstruction costs, otherwise reconstruction activity may run up against domestic financing constraints. With regard to secondary effects, the earthquake is estimated to impose an additional fiscal burden of between US$3.6-4.6 billion spread over the 1999-2000 period equivalent to 1.8 percent-2.3 percent of GNP. The earthquake is also projected to generate a widening of the current account deficit of some US$3 billion in 1999 and 2000 equivalent to about 1.5 percent of GNP largely as a result of increased economic activity arising from the reconstruction effort. The fiscal costs could rise substantially if Turkey decides on a major relocation program. The external financing of this additional current account deficit is expected to come from long-term credits and concessional funds provided by international financial organizations and Turkey's bilateral partners.

5. The earthquake has had a huge social impact. The fatality rate from the earthquake is in the range of 14.3 per thousand depending on the affected province. This is more than five times Turkey's natural annual crude death rate. Injury rates are also very high and many of the survivors are traumatized by their ordeal. An estimated 400,000-600,000 people have been left homeless. The Ministry of Education estimates that about 114,000 school-aged children are homeless as a result of the earthquake. Employment losses in the affected areas are estimated to range from 20 percent to nearly 50 percent. Addressing these social costs will impose an added burden on Turkey's social protection system over the next 16 months.

Table 1: Impact of the Marmara Earthquake: Summary Indicators

Economic Indicators 1/	1999 (US$ bn)	Share of GNP	2000 (US$ bn)	Share of GNP	Total (US$ bn)	Share of GNP
Direct Costs						
Wealth Loss	3 to 6.5	1.5% to 3.3%			3 to 6.5	1.5% to 3.3%
Indirect Costs						
Impact on Output	-2.0 to -1.2	-1.0% to -0.6%	1.4 to 2.4	0.6% to 1.1%		
Emergency assistance	-0.4	-0.2%	-0.2	-0.1%		
Secondary Effects						
Current account balance	-1	-0.5%	-2	-1.0%	-3	-1.5%
Fiscal impact	1.9 to 2.3	0.9% to 1.1%	1.7 to 2.3	0.8% to 1.1%	3.6 to 4.6	1.8% to 2.3%
Social Indicators For Affected Region due to Earthquake		Mid-Point	Range 2/			
Fatality rate	(per 1000)	7.0	2.5 to 14.3			
Injury rate	(per 1000)	15	4.6 to 27.7			
Homeless persons			400,000-600,000			
Job losses	(% of labor force)	30 9	20.4 to 48.1			

1/ All estimates based on preliminary data.
2/ Range across affected provinces.
Source: World Bank staff estimates.

6. **Damage Estimates by Sector.** Based on the available data it is possible to estimate roughly upper and lower bounds for the direct costs (i.e., wealth losses) incurred by each sector. These estimates are summarized in Table 2. The preliminary estimates for the various infrastructure sectors have been prepared by the Marmara Earthquake Emergency Recovery (MEER) team. For the housing sector, the lower bound is given as the low-end replacement cost estimated by the MEER team which is based on very modest (80 m2) apartment construction. This replacement cost does not include lost belongings and may be well below the market value of the destroyed housing units. The upper bound is computed by doubling the high-end replacement cost estimate. For the enterprise sector, the lower bound is based on the total enterprise insurance claims expected by the insurance industry and then assuming a 50 percent coverage rate on average. To this number is added the estimated inventory losses of microenterprises. The upper bound is based on losses reported to the local chambers of industry in the affected region. It is important to stress that these figures for the enterprise and housing sectors represent very rough estimates which must be verified by detailed surveys of the affected area.[2]

[2] These estimates do not include damage to the naval base in Golcuk for which no information has been reported

Table 2: Marmara Earthquake Preliminary Damage Assessment

Sector	Damage Assessment (US$ million)	
	Lower Bound	Upper Bound
Housing	1,100	3,000
Municipal Infrastructure	70	70
Environment	n.a.	n.a.
Roads, bridges, and highways	78	78
Ports	12	12
Railways, railcar factory	72	72
Telecoms	38	38
Electricity	82	82
Oil and Gas (includes Tupras Refinery)	387	387
Enterprises (rounded)	1,100	2,600
Education	100	100
Health	37	37
TOTAL	**3,076**	**6,476**

Note: Estimates are extremely preliminary based on incomplete data.
Source. Staff estimates.

7. **Government Response.** The Government's initial emergency response to the earthquake has come under severe criticism. Some of the criticism is perhaps too severe as the demands of this emergency would have initially overwhelmed virtually any emergency response system in the world. The Turkish system had performed reasonably well in responding to previous smaller-scale disasters like the 1998 Adana earthquake. Exacerbating the situation was the widespread demand for information which overwhelmed the already damaged telecommunication system. The heavy human toll and extensive material damage have also put a spotlight on the lack of effective enforcement of Turkey's building codes and the inadequate coverage of earthquake insurance in the housing sector. Moving forward, there are three areas that need urgent attention as Turkey rebuilds: (i) upgrading the emergency response system, (ii) implementing more effective mechanisms to enforce building codes, and (iii) introducing a national compulsory disaster insurance system.

8. The initial macroeconomic policy response of the Government has been appropriate and effective. The Central Bank intervention in the days following the earthquake helped calm markets and prevent a financial panic. The submission to Parliament of a supplemental tax package to help meet the budgetary cost of responding to the quake signaled Turkey's intent to maintain fiscal discipline. The subsequent adoption and enactment of major pension reform legislation in the days after the disaster helped confirm the Government's commitment to stabilization and reform. The Government has moved quickly to work with its international partners to mobilize substantial external financing for emergency relief and reconstruction. To date, up to US$3 billion in exceptional external financing has been tentatively identified. The Government is also moving to organize the reconstruction effort including defining the institutional arrangements and organizational structures to support implementation of the

reconstruction program. Moving forward, it will be critical for the authorities to sustain the momentum for stabilization and structural reform which is essential to provide the confidence to financial markets that the increase in the budget deficit needed to support relief and reconstruction will be temporary and that the budget will return to a sustainable path.

9. **Recommendations.** The Bank teams have formulated the following recommendations for consideration by the authorities in three categories:

Economic and Social

a) To the extent possible, the Government should try to mobilize external financing to meet the fiscal burden arising from the earthquake while continuing to implement the fiscal adjustment required to underpin the stabilization program. To the extent that external financing cannot meet the full fiscal burden, the Government should consider additional revenue measures and/or expenditure reductions in order to avoid the need to finance part of the burden through domestic markets.

b) It is important that the Government ensure effective coordination of external assistance related to balance of payments financing and reconstruction efforts. A focal point is needed to coordinate international financing for reconstruction. The Treasury would be the logical focal point for this coordination.

c) With respect to the Government's credit subsidy program, the Bank team recommends to explicitly limit the beneficiaries to small and micro enterprises/persons who experienced damage to their workplace. In addition, the team strongly recommends that the Government reduce substantially the interest rate subsidy element of the program. This would allow access to credit to be increased without expanding the fiscal burden.

d) Reconstruction efforts should not be used to create opportunities for further financial assistance to the already delinquent borrowers of the state banks. It is recommended to exclude from the deferral/restructuring scheme the stock of loans which have been already classified as doubtful prior to the earthquake, in order to avoid major moral hazard to the system.

e) The Government should consider policy options for those earthquake victims who are not covered by the social insurance system. The major groups are: children, uncovered adults (mostly women) and the elderly over the age of 55. The Government has two basic options for social assistance in the aftermath of the earthquake. The Government can offer a universal benefit to all of those who are not covered by social insurance. Alternatively, the Government could try to target the benefit to the most needy.

f) In order to have accurate estimates of the damage incurred by firms and households, it is recommended that the authorities carry out detailed surveys in the affected regions.

Rehabilitation and Reconstruction

g) In order to ensure an efficient and least-cost solution to temporary housing needs, it is recommended that a mix of options which can meet the needs of the displaced population be explored. The unit cost of prefab housing is estimated to be four times the cost of using existing alternative accommodation.

h) Before embarking on a major reconstruction program, it is recommended that comprehensive geological surveys be carried out to determine the feasibility of reconstructing on the existing sites and the extent to which relocation will be needed. **The reconstruction cost estimates presented in this report do not include relocation costs which could prove to be very substantial.**

i) Effective implementation arrangements with clear areas of responsibility under a comprehensive plan are essential to ensure rapid, cost-effective and high quality reconstruction program. Interagency coordination is critical.

Future Disaster Mitigation and Institutional Strengthening

j) Turkey must urgently upgrade its emergency response system in order to be prepared for large scale natural disasters in the future.

k) The Government must strengthen the enforcement of building codes throughout the country. Stiffer penalties and an effective building supervision and licensing system is urgently needed

l) The Bank team recommends that the Government consider the options for implementing a national compulsory disaster insurance scheme. Compulsory insurance will also create incentives for better enforcement of building codes.

Figure 1: GNP Growth (%)

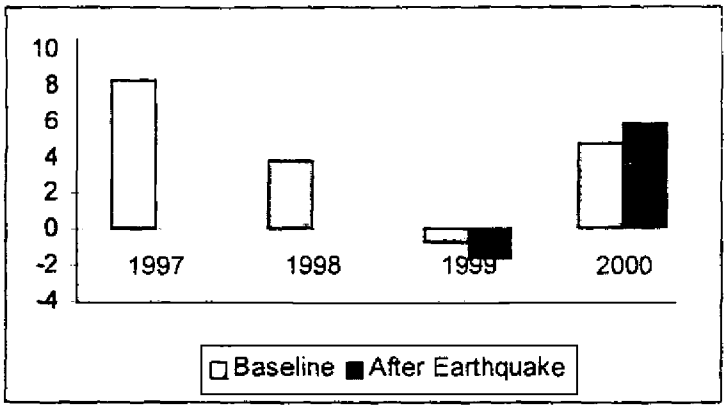


Figure 2: Current Account Balance (% of GNP)

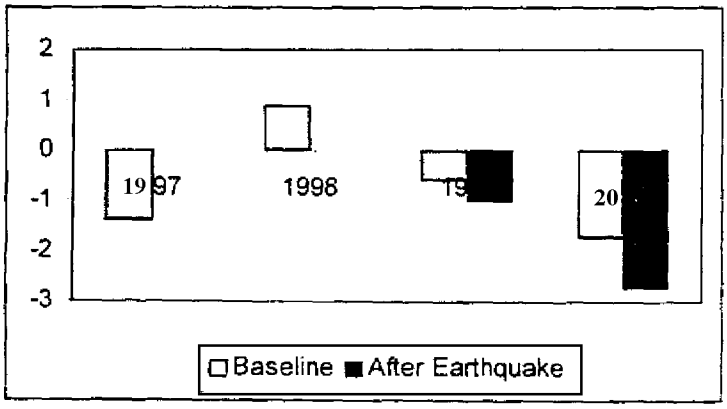
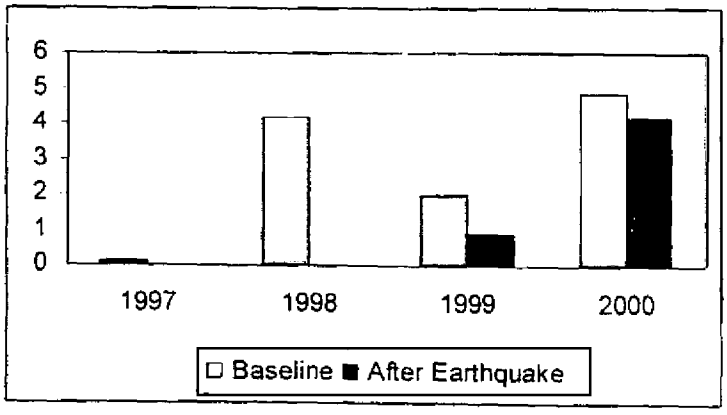


Figure 3: Primary Budget Balance



1/ Baseline for central Government budget for 1999-2000 taken from concluding statement of July SMP review. Fiscal impact is mid-point of estimated range.

Section I: Background and Overview of Marmara Earthquake Zone

A. The Earthquake and Initial Emergency Response

10. On August 17, 1999, a severe earthquake produced extraordinary damage to the area of the Marmara Sea. Areas of peak damage include the cities and regions of Kocaeli (Izmit and Golcuk), Iznik (Nicea), Gebze, Sakarya (Adapazari), Yalova and Duzce. As of September 9, the total death toll reported is 15,370 with about 24,000 injured. A preliminary analysis indicates that the length of the segments of surface breaks approach 200 km. In Degirmendere, the land level dropped by 17m and is believed to have dropped 25m under the Sea of Marmara. The epicenter of the earthquake was near Golcuk. The magnitude has been rated by the U.S. Geological Survey as 7.4 on the Richter scale, with intensity according to the Modified Mercalli Scale reaching X-XI. It lasted 45 seconds and has been followed by over 1000 aftershocks, some as high as 5.6 on the Richter scale. Damage was caused by the surface fault opening and shaking, inundation in areas that subsided, and liquefaction of the soil under buildings.

11. The earthquake created the most difficult emergency management crisis faced by any nation in recent history. The earthquake struck at 3:02 a.m., causing catastrophic damages over a wide geographic area. Communications systems linking the affected municipalities with outside agencies and organizations were destroyed. Thousands of residents were trapped in devastated buildings, including many of the officials who would be expected to provide the initial response efforts. Essential emergency response resources were either destroyed or severely damaged.

12. The impact of the earthquake was particularly severe as the event was of a high magnitude, it occurred while the population was sleeping, it affected a very densely populated area, it hit buildings and structures that had not been built according to earthquake reduction practices and mechanisms, and it took place in an area of unstable soil conditions. The time and magnitude of the event are factors that could not have been changed. However, had the construction and location of buildings integrated earthquake safety concerns, the losses could have been significantly reduced.

13. The demands of this emergency would have initially overwhelmed virtually any emergency response system in the world. The Turkish disaster response system, which had performed reasonably well in previous events like the 1998 Adana earthquake and the 1998 floods, was wholly unable to meet the demands created by the August 17 crisis. The extent of the damage caused by the Marmara earthquake overwhelmed the capacity of the government to respond.

14. Immediately after the earthquake, three critical elements of the national infrastructure failed. The main fiber optic cable between Istanbul and Ankara was cut just east of Izmit where the cable crossed the fault. This link formed the backbone of the telephone connections into the earthquake region. At the same time, two main substations on the electric power grid were damaged and dropped off line causing a

widespread power blackout across Turkey. Also an overpass on the motorway between Izmit and Ankara collapsed.

15. Confounding the situation was the widespread demand (bordering on panic) for information from the region. As the nation became aware of the quake, families outside the impacted region began to call the area to learn of the fate of loved ones. This massive demand, including from widespread cellular telephone use, caused the damaged system to fail completely. When phones failed, people got into their cars and drove to the region, further clogging the roads.

16. Efforts to respond began immediately. In three provinces the damages were catastrophic, virtually incapacitating local response capabilities. The earthquake was felt in Ankara, leading to quick actions by the key ministries. The General Directorate of Civil Defence (GDCD) officials arrived at their offices and dispatched rescue units to the affected area in trucks at 05:30 a.m. But with jammed roads, a destroyed bridge, and the fact that the vehicles didn't have radios, they didn't arrive until evening, were uncertain where to go, and, ultimately, had little effect. The GDCD began to alert all the provinces and request information about roads, water supply, gas electricity, damaged buildings using three fax machines. With the degradation of the phone system, and the efforts to return messages to the GDCD, this effort took three hours. The Health Ministry mobilized 139 ambulances and 110 doctors to the region by 06:30 a.m.

17. By 04:30 a.m. the General Secretary's crisis center in the office of the Prime Minister (PMCC) was organized, with the crisis monitoring committee in place by 06:30 a.m. Key ministries established crisis centers around Ankara and regionally. However, all communications to the affected area were down by this time. The only information came from media teams in the devastated areas. The PMCC directed Turkish Telecom to send satellite telephones to the affected area. These were sent by road and arrived 17 hours after the quake. With the arrival of satellite telephones and repair of the severed fiber optic cable, electric power was restored in the affected region within 48 and communications within 63 hours after the quake.

B. Impressions from Site Visits

18. The team visited the cities of Izmit, Golcuk, Yalova, Adapazari, Duzce, Bolu, and Istanbul, and flew over various other smaller towns and villages in the area. In addition, team specialists spent a number of days in the area discussing damage to specific types of structures and installations. Although the views from the air were useful for assessing the extent of some of the most serious damage, the real impressions were gained from the ground where the extent of the damage shocked even those with extensive experience with earthquake devastation. Some brief impressions were as follows:

- In Izmit, the team was informed that approximately 14,000 housing units had collapsed; water, sewerage, roads, schools, hospitals health centers were damaged.

- In Golcuk, there was significant damage to much of the center of the city and parts of the naval base. Damage was reported to ports and private piers, and most of the waterfront park was underwater. However, no major damage to industrial enterprises was reported. It appeared that many of the buildings which suffered total collapse were of substandard construction, given the proximity of buildings which had remained standing. However, significant damage was also due to the location of the buildings directly over the fault line itself.

- Yalova is located directly on the water and its main industry is tourism. A high proportion of the damaged housing consisted of second homes and the number of homeless in the city, while significant, was much lower in proportion to the loss of housing stock than in other cities. No information was provided concerning water or sewerage, but damage to telecommunications and electricity supply appeared limited. The necessity to provide temporary housing outside the city or to construct temporary housing for those rendered homeless is not clear given the quantity of vacant holiday housing in the city during the winter.

- The damage in Adapazari was so extensive that first impressions suggested that the whole of the city center would require rebuilding – and possibly in an alternative location, though the few buildings with foundations adapted for the soil structure were virtually undamaged. The main problem resulted from the liquefaction of the ground underneath buildings which had been built without the necessary pile foundations. Hence, many of the buildings had sunk several meters into the ground, and pavements and roads had buckled up. Only 15 percent of the city was supplied with water. The team estimated that the rebuilding of this city would require more time and more careful planning than the other areas which it visited. Rebuilding in the same location would require much higher cost/quality construction.

19. Other cities visited, such as Bolu and Duzce, also suffered significant damage. In addition to the cities, it was clear from the air that apartment buildings in villages and small towns had also collapsed completely, which would indicate that other buildings had also suffered damage. No estimates for the extent of the damage in rural areas are available anywhere at the present time.

C. Economic Overview of the Earthquake Zone

20. **Kocaeli.** The damage in Kocaeli is concentrated in three districts, the Merkez district that harbors the province center İzmit, Gebze and Gölcük. The first two are to the north of the Gulf of Marmara. Gölcük is to the south and on the fault line that gave way. In 1997, Merkez and Gebze respectively contained 38 and 34 percent of Kocaeli's resident population, while Gölcük contained 11 percent. Since the city of Gölcük is a summer resort, its population at the time of the earthquake must have been significantly higher. The presence of a large naval base is likely to have been a major boon to the local economy. The epicenter of the earthquake being nearby, the facilities of the base have suffered significant damage.

21. By contrast Izmit (Merkez) and Gebze's economies rest on an industrial base. Almost all of Kocaeli's manufacturing industry is concentrated along the narrow strip from Gebze to Izmit. To put things in perspective, in 1997, Kocaeli accounted for 3.8 percent of the establishments, 5.1 percent of the workforce, and 15.3 percent of the value added in Turkish manufacturing. With some exceptions (most notably Tüpraş, Turkey's largest refinery) large manufacturing establishments did not suffer major damage and are expected to resume normal production within one or two months (see partial list in the Annex). Based on anectodal evidence, the earthquake has exacted a heavier toll on small and medium enterprises. Many of these supply inputs to large companies in the area. Available data indicate that firms with less than 10 workers account for 95 percent of Kocaeli's manufacturing establishments and about 35 percent of the workforce.

22. **Sakarya.** The Merkez district which contains the province center Adapazarı appears to have received the brunt of the blow, at least in terms of human casualties. In 1997, Adapazarı and its villages contained 49 percent of Sakarya's resident population. About one-half of the inhabitants of Merkez lived in villages. Sakarya province on the whole may be characterized as the vegetable and fruit basket of the Marmara region. In 1997, it accounted for 1.1 percent of the establishments, 1.2 percent of the workforce, and less than 1 percent of the value added in Turkish manufacturing. TV and news reports from Adapazarı concentrated on collapsed modern multi-story (5,6, even 7 floors) apartment buildings and underscored the urban focal point of the tragedy. Many of the collapsed and damaged buildings had 'soft' ground floors, occupied by business establishments. Based on site visits, the team's impression is that the earthquake wiped out entire sections of modern urban Adapazarı, and inflicted huge losses on the urban small business community (largely retail businesses). Satellite imagery corroborates this view.

23. **Yalova.** Although it is the smallest of the provinces on the worst-hit list (with 164,000 year-around residents in 1997), Yalova suffered a disproportionately high death toll when entire housing complexes collapsed. The city, after which the province is named, as well as the neighboring towns that dot the coastline, were popular summer resorts. After the earthquake the mayor of Yalova was quoted as saying that the city was home to six times as many people as the resident population during the summer months. Now that the poor quality of the geological foundations of many of the housing complexes has become public knowledge, Yalova is not likely to regain its pre-earthquake popularity as a summer resort. This will surely bring the local construction boom to a halt and deal a stiff blow to the retail and service sectors of the local economy.

24. The earthquake's immediate economic impact will be felt in at least two other provinces, Bolu and İstanbul. Two districts of Bolu, Düzce and Gölyaka suffered significant damage. Düzce (like Adapazarı) benefited from being on the Ankara-İstanbul highway. As in Adapazarı, the earthquake appears to have exacted a toll on the small- and medium-scale establishments. In the much smaller and rural Gölyaka the housing stock appears to have been damaged significantly. The housing stock in Avcılar, a poor suburb of İstanbul that experienced uncontrolled expansion in the 1990s, also took a heavy blow. Early indications are that Istanbul will experience a redistribution of population from districts that have unstable geological foundations to those sitting on

rock beds. Compared with those already discussed, the earthquake's economic consequences in the remaining three provinces affected (Bursa, Eskişehir and Zonguldak) appears to be less severe.