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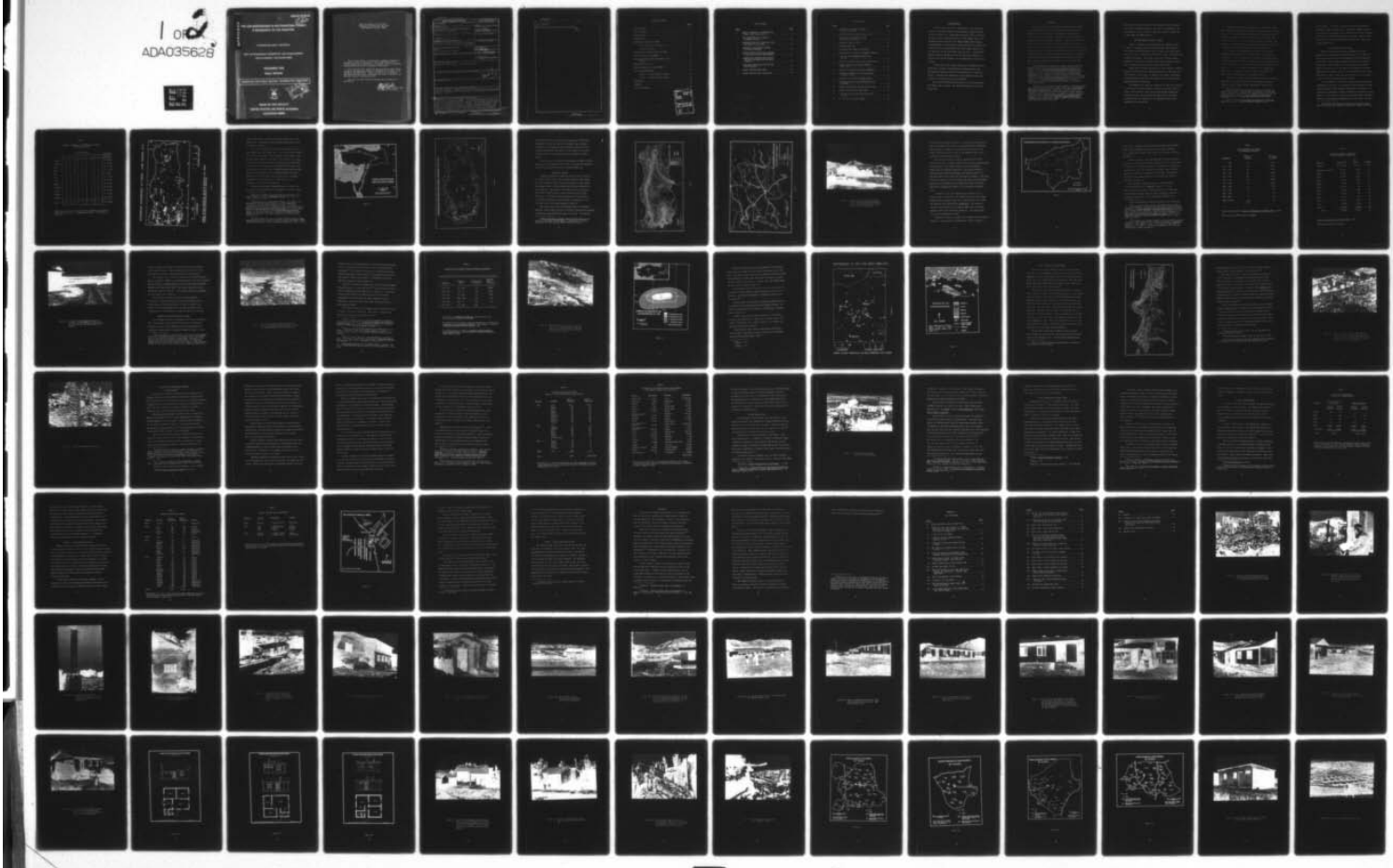

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THE LICE EARTHQUAKE IN SOUTHEASTERN TURKEY: A GEOGRAPHY OF THE DISASTER

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FINAL REPORT

DEAN OF THE FACULTY

UNITED STATES AIR FORCE ACADEMY

COLORADO 80840

Editorial Review by Lt Col Elser
Department of English and Fine Arts
USAF Academy, Colorado 80840

This research report is presented as a competent treatment of the subject, worthy of publication. The United States Air Force Academy vouches for the quality of the research, without necessarily endorsing the opinions and conclusions of the author.

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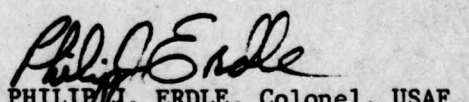

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cont. future reconstruction practices are offered.

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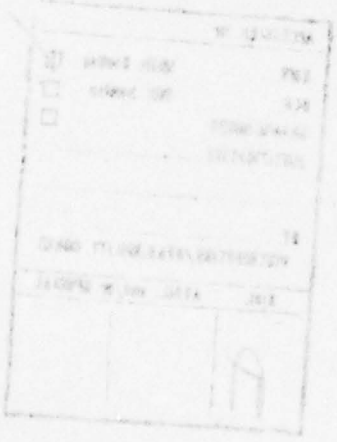

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I wish to express my sincere appreciation to the following persons who provided information and generously cooperated during my visit to Turkey. Mr. Teoman Güzey, Executive Director, Ministry of Reconstruction and Resettlement; Mr. Oktay Ergünay, Head of the Earthquake Research Institute; Mr. Mehmet Gündüz, Göksel Öztürk, and Ayar Özdemir of the Diyarbakır Regional Division of the Ministry of Reconstruction and Resettlement; Mr. Ünal Cengiz, Governor of Lice District; and Mr. Halil Akgül, Mayor of Lice. I particularly thank Mr. Nürettin Aytemizel of the Lice field team, Ministry of Reconstruction and Resettlement, for accompanying me to many of the villages.

I am grateful to the Turkish Ministries of Reconstruction and Resettlement, Interior, Foreign Affairs, Internal Security and the Diyarbakır Provintial Police for permitting me to conduct this project. Professor Erol Tümertekin of the Geographical Institute, University of İstanbul, was also very helpful.

Major Richard Wolniewicz devoted much of his time developing the computer maps of Turkey. His cheerful assistance is sincerely appreciated.

INTRODUCTION

Social scientists are increasingly addressing their research toward problems that may assist in reducing losses which natural hazards inflict upon societies. Consequently, there is now a relatively large and expanding literature concerned with natural hazards and disaster research in general.[1] This natural hazard research includes the examination of human adjustment and exists in part to provide interpretive insight so that mankind may benefit from such experiences. The importance and need for additional empirical case studies addressing the nature and extent of adjustment to disasters has been recognized for both developed and developing countries.[2] This report is an attempt to meet this need. It systematically

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[1] A comprehensive introduction to natural hazard research is provided by Anita Cochran: A Selected Annotated Bibliography of Natural Hazards, Natural Hazard Research Working Paper No. 22, (Toronto: University of Toronto, Department of Geography, 1972); Gilbert F. White: "Natural Hazards Research," in Directions in Geography (edited by Richard J. Chorley; Methuen and Co., Ltd., London, 1973), pp. 193-216; and James K. Mitchell: "Natural Hazards Research," in Perspectives on Environment (edited by Ian R. Manners and Marvin W. Mikesell; Association of American Geographers, Commission on College Geography, Publication No. 13, Washington, 1974), pp. 311-341.

[2] The need for research on natural hazards in developed societies is discussed in Gilbert F. White and J. Eugene Haas, Assessment of Research on Natural Hazards. (Cambridge: The MIT Press, 1975). Both NATO and CENTO have recognized the need for natural hazard research in developing societies. See Committee on the Challenges of Modern Society, NATO Disaster Assistance: Earthquake Hazard Reduction, No. 9, no date, and Earthquake Hazard Minimization Conference, July 22-27, 1968, (Ankara: CENTO, Office of United States Economic Coordinator, 1969).

describes the nature and extent of the September 6, 1975 earthquake near Lice in southeastern Turkey. The report is comprehensive and was designed to serve for future comparative studies in Turkey and in other NATO and CENTO countries.

THE GEOGRAPHICAL SETTING OF TURKEY

Turkey is situated in the western part of southwestern Asia. It forms a rectangular peninsula extending about 1500 kilometers east to west and 625 kilometers north to south at its widest point. Its area includes 754,200 square kilometers in Asia, and 25,700 square kilometers in Europe. Thus, with a total area of 789,576 square kilometers, the country is slightly larger than the state of Texas, but has a population density almost three times greater.

Turkey shares political boundaries with six countries: Bulgaria and Greece in the west; the Soviet Union and Iran in the east; and Iraq and Syria in the south. In addition, the country is bordered by the Black Sea to the north, the Aegean Sea to the east, and the Mediterranean Sea to the south.

The population of Turkey was 35,605,176 in 1970, with a density of forty-five per square kilometer. Turks are a cohesive cultural group and are united in their pride of the Turkish language and religion of Islam. Unity in national pride has been especially pronounced since the emergence of the independent nation-state immediately after World War I.

Today Turkey is experiencing rapid social and economic change. While differences between the urban and rural population are narrowing, there are still marked regional differences in economic development. For example, changes are occurring faster along the coastal zones than in the interior, and faster in the west than in the east. The villagers, who make up sixty-two percent of the population and live in approximately 36,000 villages, are the least affected.

The geology and geomorphology of Turkey are very complex. Although the geomorphology of the country can be stated simply as consisting of a large plateau that is enclosed on all sides by east-west trending mountain ranges, it should be noted that numerous local features are present that partially invalidate such a general statement. For example, the Anatolian plateau is not a single block system, but is crossed by a system of faults. In addition, the plateau contains uplifted blocks and sunken basins.[3]

Centuries of folding, faculting, igneous intrusions, uplifting, and erosion of Tertiary sediments over pre-Cambrian crystalline rocks have shaped Turkey's present topography.[4] There is very

---

[3]Dewdney presents this argument in depth and discusses the relief and structure of Turkey under the headings of the Northern Folded zone, the Central Massif, the Southern Folded zone, and the Arabian platform. See J.C. Dewdney, Turkey, An Introductory Geography (New York: Praeger Publishers, 1971), pp. 15-27.

[4]George B. Cressey, Crossroads, Land and Life in Southwest Asia (Chicago: J.B. Lippencott Company, 1960), p. 256.

little lowland. It is mostly a region of plateaus and mountains with high altitude and rough relief. Turkey has a higher elevation in the east than in the west, and is bordered by the Pontic mountains in the north and the Taurus mountains in the south. About one-half of Turkey has an average elevation above 1600 meters. Large areas are above 2500 meters.

The Earthquake Risk in Turkey

Turkey has experienced devastating earthquake disasters dating back to the beginning of recorded history. Since 1900 the country has experienced over 700 earthquakes of Richter magnitude 4.0 or greater, with a higher frequency occurring in the months of March, April, and May (Table 1).[5] For the past several decades Turkey has experienced, on the average, one earthquake of Richter Magnitude 6.0 or greater each year. The seriousness of this earthquake threat is quite evident when one considers the poor quality of housing construction throughout most of Turkey.

It is reasonable to assume that areas which have experienced earthquakes in the past, or are located in close proximity to areas of past seismicity, will experience earthquakes in the future. By plotting past earthquakes, Turkey's vulnerability becomes very clear (Figure 1). The country is located in the Alpide Belt of seismicity which is one of the great earthquake belts of the world. The zone

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[5]Provided by the National Geophysical and Solar-Terrestial Data Center, NOAA, U.S. Department of Commerce, Boulder, Colorado.

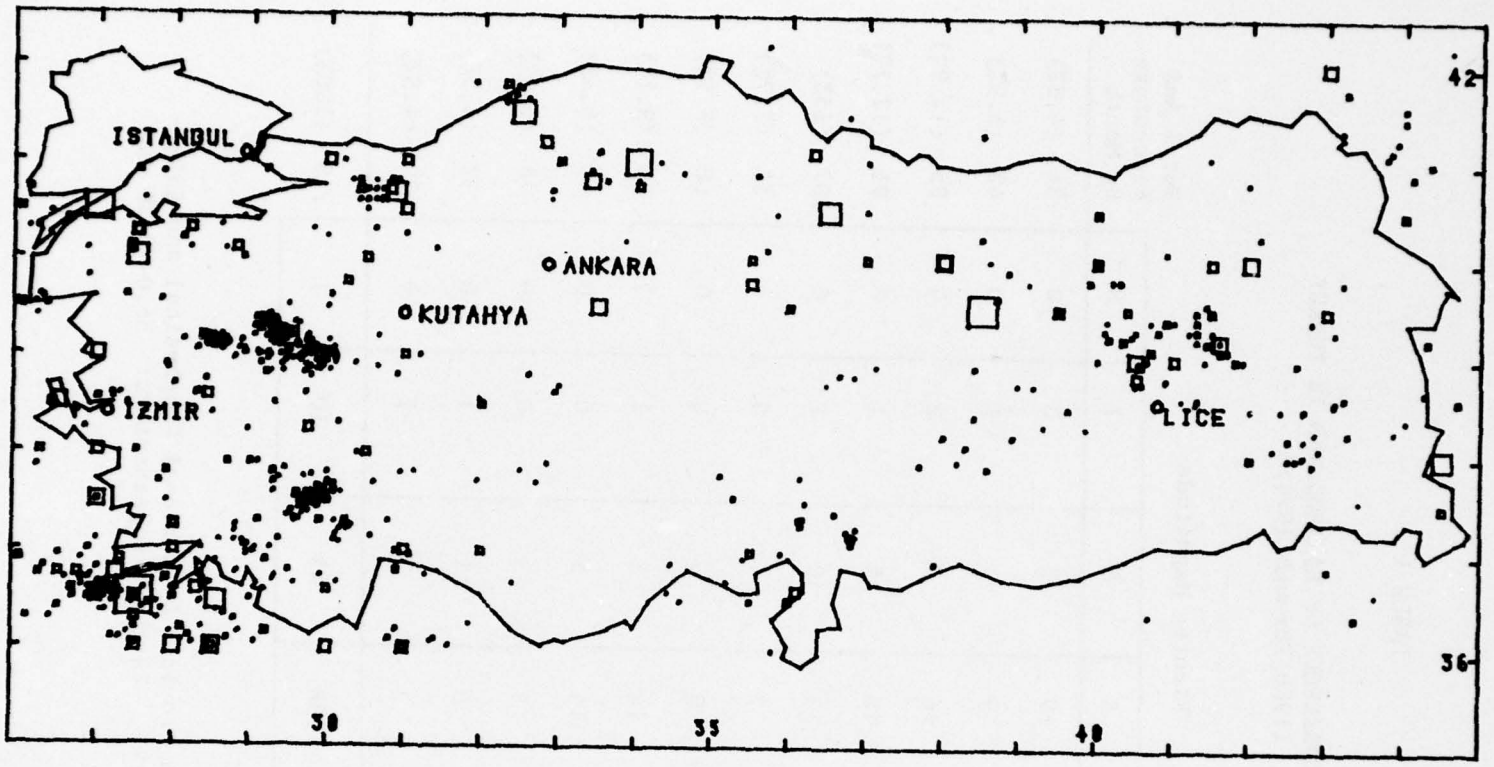
TABLE 1

MONTHLY OCCURRENCES OF EARTHQUAKES IN TURKEY
(1900 Through 1974)*

	Richter Magnitude					Total And Percentage By Month
	4	5	6	7	8	
January	21	10	3	0	0	34 (4.8%)
February	31	9	1	1	0	42 (5.9%)
March	65	16	2	2	0	85 (11.9%)
April	67	18	5	1	0	91 (12.7%)
May	82	13	10	2	0	107 (15%)
June	43	7	4	0	1	55 (7.7%)
July	43	20	5	0	0	68 (9.5%)
August	45	14	5	1	0	65 (9.1%)
September	41	14	5	0	0	60 (8.4%)
October	33	8	3	0	0	44 (6.2%)
November	24	6	1	1	0	32 (4.5%)
December	26	3	1	2	0	32 (4.5%)
Total	521	138	45	10	1	715 (100%)

*Calculated from data provided by National Geophysical and Solar-Terrestrial Data Center. Earthquake parameters: 36.0-42.2N and 26.0-44.8E.

EARTHQUAKE OCCURRENCES IN TURKEY: 1900 THROUGH 1974



SOURCE: NATIONAL GEOPHYSICAL AND SOLAR-TERRESTRIAL DATA CENTER
PLOTTED BY MAJOR RICHARD WOLNIEWICZ AT USAFA/ERCC

Figure 1

extends from Sumatra, through the Himalayas, Afghanistan, Iran, Turkey, Greece, Yugoslavia, Italy, the Swiss Alps, and on to the mid-Atlantic region.[6]

There are two fairly well-defined lines of epicenters in Turkey (Figure 2). The largest line or zone of epicenters extends for a total of 900 km west to east through northern Turkey, with an angle toward Lake Van in the east.[7] This seismic area is part of the North Anatolian fault zone. The second line of epicenters are believed to be an extension of the Dead Sea fault zone. This second zone of epicenters trend northeast-southwest and intercepts the North Anatolian fault zone near Bingöl (about 39°N, 31°E). Thousands of lives have been lost near this area to earthquake catastrophes in 1939 (Erzincan), in 1966 (Varto), in 1971 (Bingöl), and in 1975 (Lice) (Figure 3).

Based on the 1972 map of earthquake zones in Turkey, over 90 percent of the 780,576 kilometers squared[8] area of the country,

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[6]William A. Mitchell, "Reconstruction After Disaster: The Gediz Earthquake of 1970," Geographical Review, Vol. 66, No. 3 (July, 1976), pp. 297-299.

[7]Obviously this is an approximate figure. The length of the North Anatolian Fault has been stated at 1,100 kilometers by Tasdemiroglu and "over 900" kilometers by Allen. See Mehmet Tasdemiroglu, "The 1970 Gediz Earthquake in Western Antolia, Turkey," Bulletin of the Seismological Society of America, Vol. 61 (December, 1971), p. 1507, and Clarence Allen, Active Faulting in Northern Turkey, Contribution Number 1577, Division of Geological Sciences (Pasedena, California: California Institute of Technology, May, 1969), pp. 2-4.

[8]Excluding lakes, the area is 744,815 kilometers squared. Genel Nufus Sayimi (Census of Population by Administrative Divisions, Turkey, 25 October 1970) (Ankara: State Institute of Statistics, 1973), p. xvii.

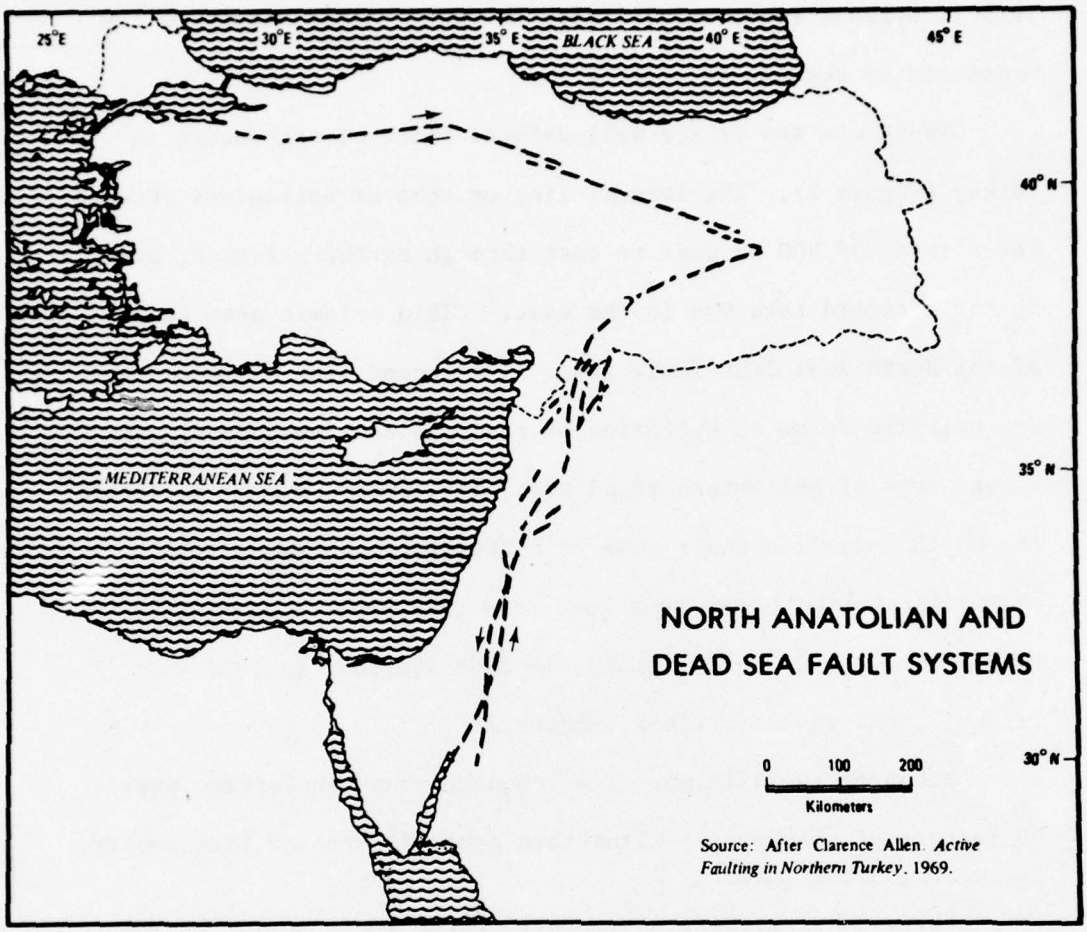
25° E
30° E
35° E
BLACK SEA
40° E
45° E
40° N
35° N
30° N
MEDITERRANEAN SEA
NORTH ANATOLIAN AND
DEAD SEA FAULT SYSTEMS
0
100
200
Kilometers
Source: After Clarence Allen. Active Faulting in Northern Turkey. 1969.

Figure 2

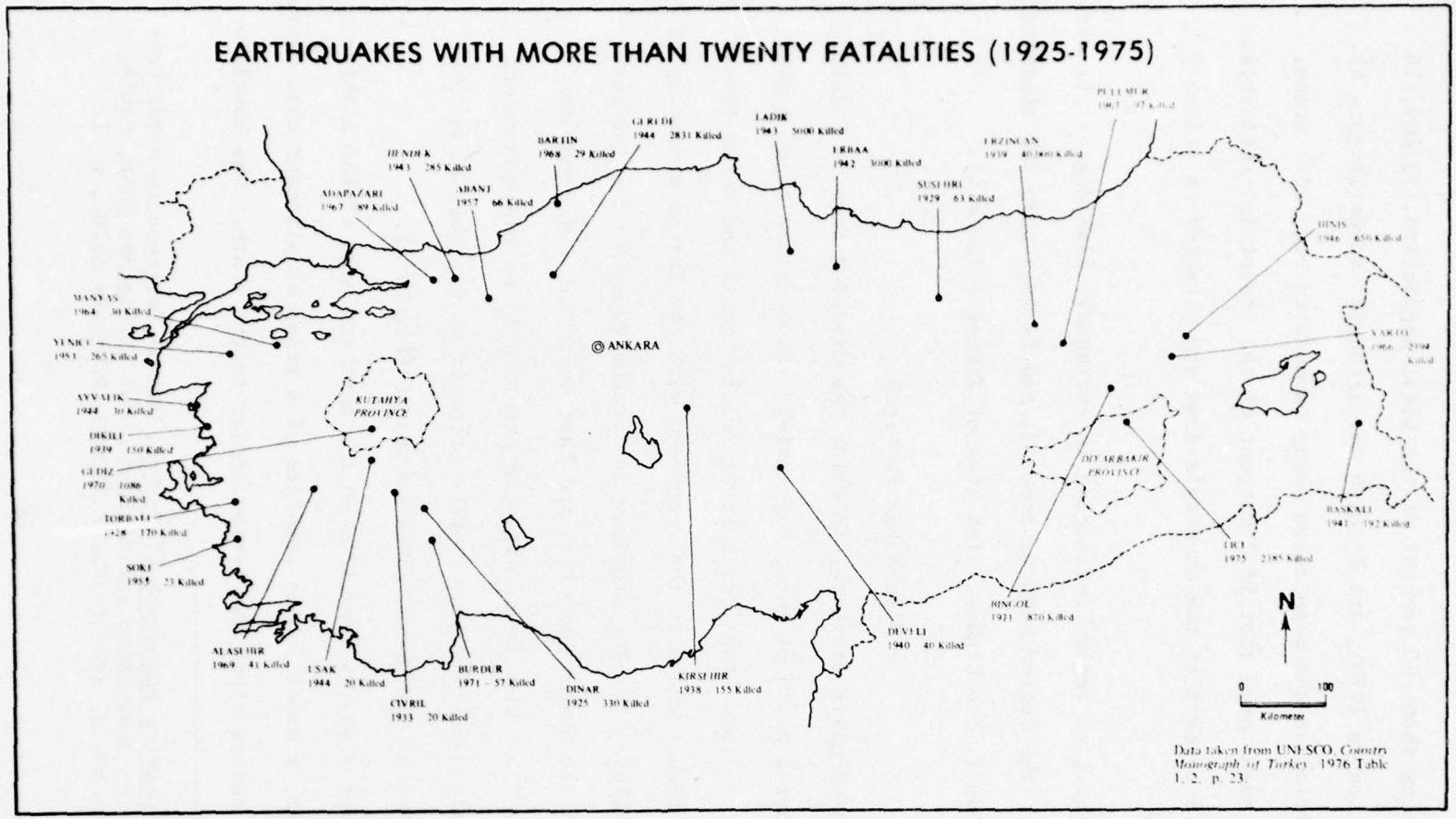
EARTHQUAKES WITH MORE THAN TWENTY FATALITIES (1925-1975)
ANKARA
KUTAHYA PROVINCE
DIYARBAKIR PROVINCE
BINGOL 1971 – 870 Killed
DEVELI 1940 – 40 Killed
KIRSEHIR 1938 – 155 Killed
DINAR 1925 – 330 Killed
BURDUR 1971 – 57 Killed
USAK 1944 – 20 Killed
CIVRIL 1933 – 20 Killed
ALASEHIR 1969 – 41 Killed
SOKE 1955 – 23 Killed
TORBALI 1928 – 170 Killed
GEDIZ 1970 – 1086 Killed
DIKILI 1939 – 150 Killed
AYVALIK 1944 – 30 Killed
YENICE 1953 – 265 Killed
MANYAS 1964 – 30 Killed
ADAPAZARI 1967 – 89 Killed
BENDEK 1943 – 285 Killed
ABANT 1957 – 66 Killed
BARTIN 1968 – 29 Killed
GEREDE 1944 – 2831 Killed
LADIK 1943 – 5000 Killed
ERBAA 1942 – 3000 Killed
SUSEHRI 1929 – 63 Killed
ERZINCAN 1939 – 40,000 Killed
PULUMUR 1967 – 97 Killed
BINGOL 1946 – 650 Killed
VARTO 1966 – 2394 Killed
BANKALI 1941 – 192 Killed
LICI 1975 – 2385 Killed
N
0
100
Kilometer
Data taken from UNESCO, Country Monograph of Turkey, 1976 Table 1, 2, p. 23.

Figure 3

containing about 95 percent of the total population (35,605,176 population in 1970), are located in earthquake zones (Figure 4). In addition to the population being exposed to high risk areas, it has been noted that 98.3 percent of the industrial activities and 91.6 percent of the country's dams are situated in seismic zones.[9]

The Lice region is located in earthquake risk degree III zone; however, the region borders zone II, and is less than 100 kilometers from zone I, the highest risk area of Turkey (Figure 4).

Diyarbakır Province

Diyarbakır province, in which the disaster area is located, is situated south of where the anti-Taurus mountain range begins its curve around the Tigris river (Dicle) basin and turns toward the southeast where it then connects with the Zagros mountains of Iran (Figure 5). The province is located close to the juncture area of the North Anatolian and East Anatolian fault systems (Figure 2). Lice town, situated practically on the epicenter, is located 75 kilometers north-northeast of Diyarbakır, on the very edge of the anti Taurus mountains (Figure 6).

The disaster area sits on the northern edge of the Arabian platform, a massif which consists of a group of plateaus that decrease to 400 meters along the Syrian border to the south. The basaltic

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[9] Country Monograph of Turkey, UNESCO, Intergovernmental Conference on Assessment and Mitigation of Earthquake Risk, Paris, February 10-19, 1976 (Ankara: UNESCO, February 1976), p. 1.

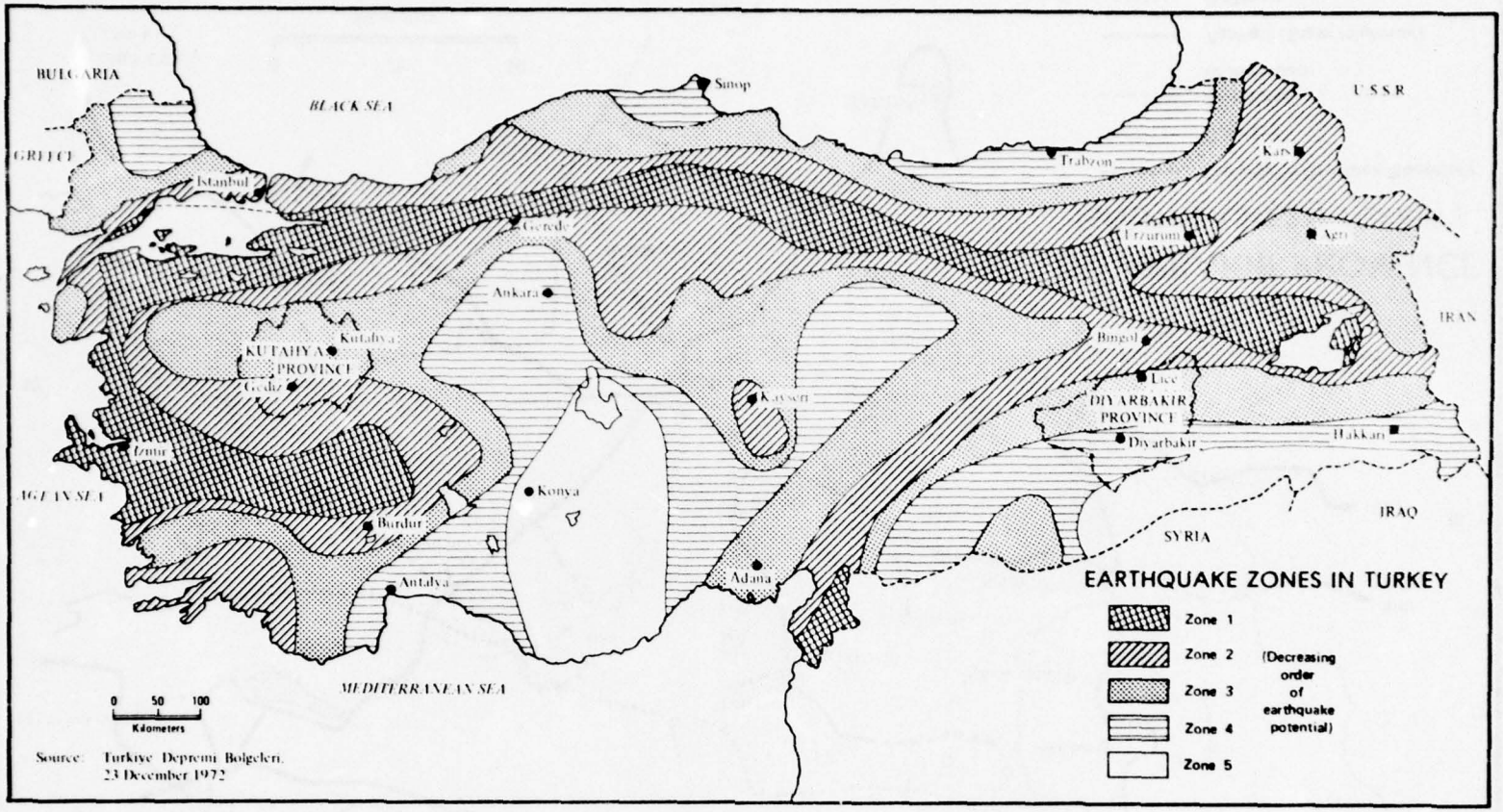
BULGARIA
BLACK SEA
GREECE
Istanbul
Sinop
USSR
Trabzon
Kars
Agri
Erzurum
Gerede
Ankara
IRAN
Bingol
Kutahya
KUTAHYA
PROVINCE
Usak
Lice
Kayseri
DIYARBAKIR
PROVINCE
Izmir
Diyarbakir
Hakkari
AEGEAN SEA
Konya
IRAQ
Burdur
SYRIA
Antalya
Adana
MEDITERRANEAN SEA
EARTHQUAKE ZONES IN TURKEY
Zone 1
Zone 2
Zone 3
Zone 4
Zone 5
(Decreasing order of earthquake potential)
0 50 100
Kilometers
Source: Turkiye Depremi Bolgeleri.
23 December 1972

Figure 4

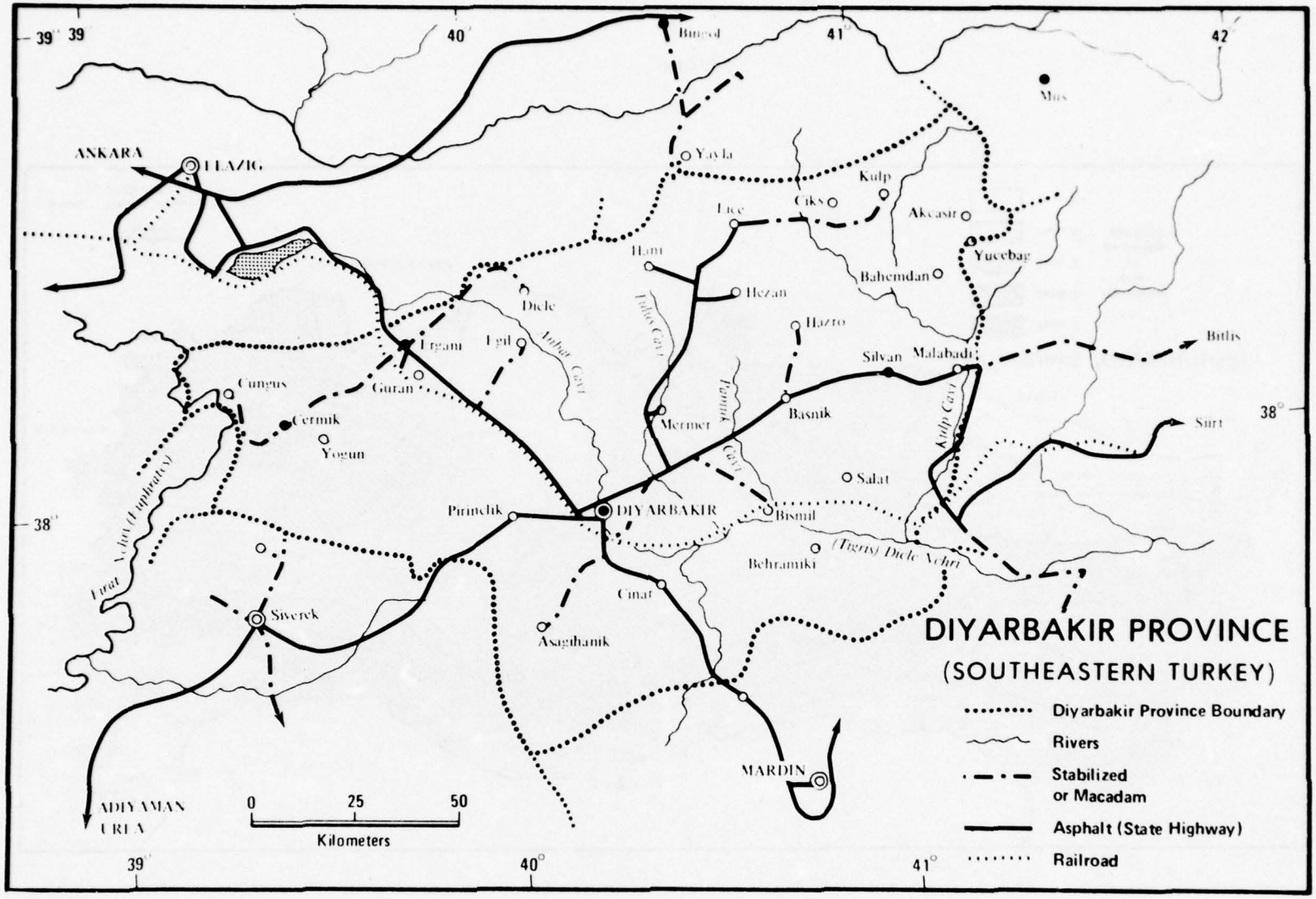
39°
39
40°
41°
42
ANKARA
ELAZIG
Bingol
Mus
Yayla
Kulp
Cikis
Akcasir
Lice
Yucebag
Ham
Bahemdan
Hezan
Dicle
Hazro
Ergani
Egil
Silvan
Malabadi
Batman Cayi
Tigris Cayi
Kulp Cayi
Bitlis
Cungus
Guran
Cermik
Mermer
Basnik
Siirt
38°
Yogun
Salat
Pirinclik
DIYARBAKIR
Bismil
Behramiki
(Tigris) Dicle Nehri
Euphrates (Firat) Nehri
Cinar
Siverek
Asagihamik
MARDIN
ADIYAMAN
URFA
0
25
50
Kilometers
DIYARBAKIR PROVINCE
(SOUTHEASTERN TURKEY)
Diyarbakir Province Boundary
Rivers
Stabilized
or Macadam
Asphalt (State Highway)
Railroad

Figure 5

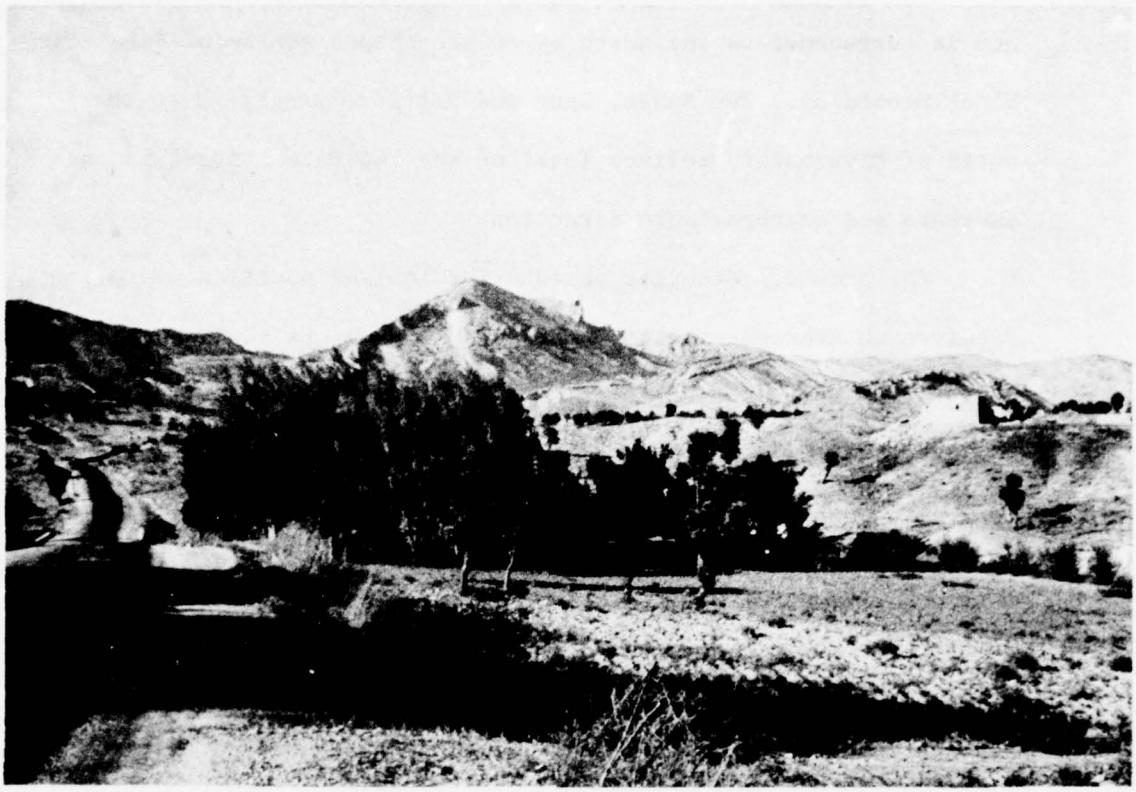

Figure 6. Approaching Lice from the Southwest on the newly asphalted Diyarbakır-Lice road. Note the thrust fault system in the center of the picture.

plateau on which Diyarbakır Province is situated averages 600 meters and is surrounded on the north by an arc-shaped series of Paleozoic block mountains. The Maden, Genç and Bitli ranges trend to the north of Diyarbakır province (east of the Euphrates river) in an eastward and southeastward direction.

The province occupies an interior lowland position which receives an average of eighteen inches of preciptation annually, mostly in early winter. The earliest snow fall is in late November. January daily mean minimum temperature is 26 degrees Farenheit, contrasted with a daily mean maximum of 99 degrees Farenheit in July (the highest ever recorded was 108 degrees Farenheit). The result is that the region is one of the hottest and driest areas of Turkey. Vegetation in this semi-arid zone ranges from steppe in the west and south to deciduous and conifer in the northern and eastern areas.

Diyarbakır is one of 67 administrative provinces (il) in Turkey, which are divided into 572 administrative districts (ilce), somewhat like an American county seat. Many districts are divided into administrative sub-districts (bucak ilce). The provinces, districts and sub-districts are normally named after the largest community within their individual boundaries. The village (köy) is the lowest administrative level.

Diyarbakır province is divided into 12 administrative districts (Figure 7). These districts and population of their capitals or

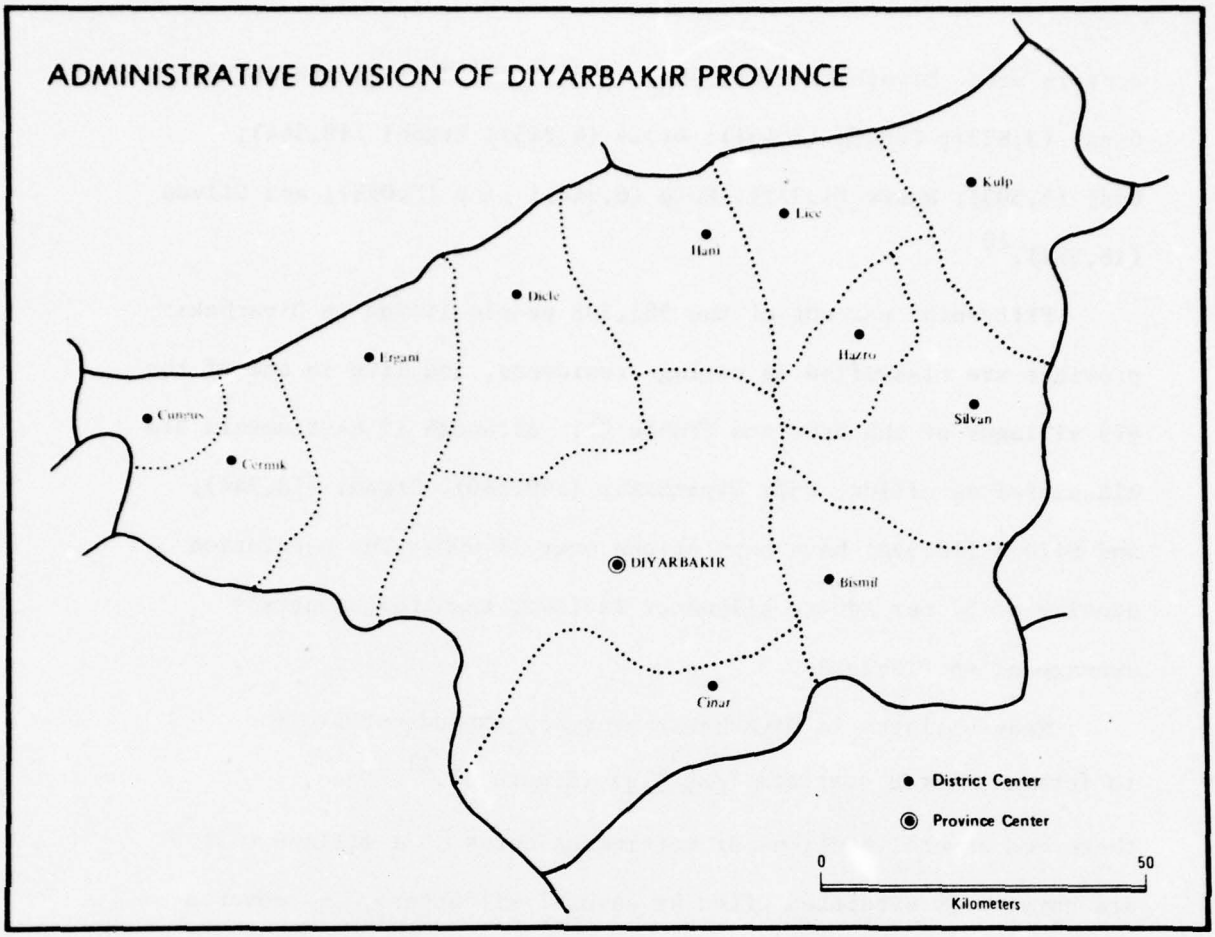
ADMINISTRATIVE DIVISION OF DIYARBAKIR PROVINCE
Kulp
Lice
Hani
Dicle
Hazro
Ergani
Silvan
Cuncus
Cermik
DIYARBAKIR
Bismil
Cinar
District Center
Province Center
0
50
Kilometers

Figure 7

centers are: Diyarbakır (149,566); Bismil (9,403); Çermik (6,910); Çınar (3,823); Çüngüş (3,161); Dicle (4,245); Ergani (18,544); Hani (5,500); Hazro (4,321); Kulp (6,346); Lice (8,093); and Silvan (18,592).[10]

Fifty-nine percent of the 581,208 people living in Diyarbakır province are classified as village residents, and live in one of the 673 villages of the province (Table 2). Although 12 settlements are classified as cities, only Diyarbakır (149,566), Ergani (18,544), and Silvan (18,592) have populations over 10,000. The population density of 37 per square kilometer is lower than the country's average of 45 (Table 3).

Many villages in Diyarbakır province expand outwardly to form scattered quarters (mahalle) (Figure 8).[11] Thus, there are several sections or settlement cores of a village that are physically separated often by several kilometers, and cover a relatively large area.[12] These dispersed settlements are a

---

[10]All of the population figures are based on the 1970 census.

[11]For an excellent discussion of settlement types in Turkey, see: Necdet Tunçdilek, "Types of Rural Settlements and Their Characteristics," in Turkey: Geographic and Social Perspectives, edited by Peter Benedict, Erol Tümertekin, and Fatma Mansur (Leiden: E.J. Brill, 1974), pp. 48-70 and John Kolars, "Types of Rural Development," in Four Studies on the Economic Development of Turkey, edited and co-authored by Federic C. Shorter (London: Frank Cass and Co., Ltd., 1967), pp. 63-87.

[12]For example, the village of Baharlar (Lice District) consisted of Sünzer, Berbik, Süngeran, Hun, Antikan, and Hamzabey mahalleler (quarters). The number of houses in each quarter ranged from 3 in Hamzabey to 12 in Sünzer. Total houses numbered 44, and they were scattered over several kilometers.

TABLE 2

SIZE DISTRIBUTION OF VILLAGES
IN DİYARBAKIR PROVINCE[a]

Population	Number of Villages	Percentage of Total[b]
1 - 100	15	2.23
101 - 200	68	10.10
201 - 300	90	13.37
301 - 400	111	17.49
401 - 500	106	16.75
501 - 750	165	25.52
751 - 1000	75	11.44
1001 - 1500	35	5.20
1501 - 2000	5	.74
2001 - 2500	1	.14
2501 - 3000	1	.14
3001 and above	1	.14
	673	

[a]Calculated from data in Census of Population, 25 October 1970, p. 189.

[b]Does not total 100% because of rounding.

TABLE 3

DİYARBAKIR PROVINCE: POPULATION, AREA AND DENSITY BY DISTRICTS[a]

Districts	Population[b]	Area (Km^2)	Density
(Turkey)	(35,666,549)	(779,445)	(46)
Diyarbakir (Capital)	216,963	3,010	72
Bismil	45,462	1,748	26
Çermik	34,297	1,032	33
Çınar	28,344	1,952	14
Çüngüs	15,738	489	32
Dicle	28,737	738	38
Ergani	50,766	1,489	34
Hani	19,192	415	43
Hazro	16,310	419	38
Kulp	35,761	1,601	22
Lice	38,442	1,083	35
Silvan	52,196	1,379	37
Total	581,208	15,355	37

[a]Census of Population, 25 October 1970, p. 189.

[b]Population per square kilometer.

Figure 8. A Typical Village Mahalle Between Lice and Kulp. Several houses like the one on the left have been recently added to the village.

result of rough relief features, poor soil conditions, and various socio-economic factors. These settlements are practical for the predominately livestock economy found in much of the province.

The disaster area is sparsely populated and inhabited by people who are principally engaged in raising sheep, goats, and cattle, and subsistence farming. Although there are areas of intensively cultivated alluvial soils along stream beds,[13] the land is generally of poor agricultural quality (Figure 9). Poor economic conditions throughout the area reflect this condition.

Access between village and town is a serious problem in the area. Although the district centers are connected by all weather roads of fairly good quality, I found it impossible to travel to several villages because of the road conditions. Many villages have no roads suitable for motorized vehicles of any type.

SEISMICITY AND GEOLOGY OF THE LİCE AREA

The earthquake occurred at 1220 hours local time on September 6, 1975. The epicenter of the main shock was only a few kilometers northeast of Lice, at 38.57 degrees north and 40.80 degrees east. Preliminary reports placed the magnitude between 6.6 and 6.7 on the

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[13] The most important alluvial soils are along the Tigris (Dicle) which enters Diyarbakir province from the north, about 40 kilometers west of Lice, and flows southward to Diyarbakir, then turns to the east, paralleling the province's southern border. The Euphrates (Firat) parallels the western border of the province. Other important streams are the Furtakso, Kuru, Pamek, Ambar, Gödsü, and Aşağı Hanik.

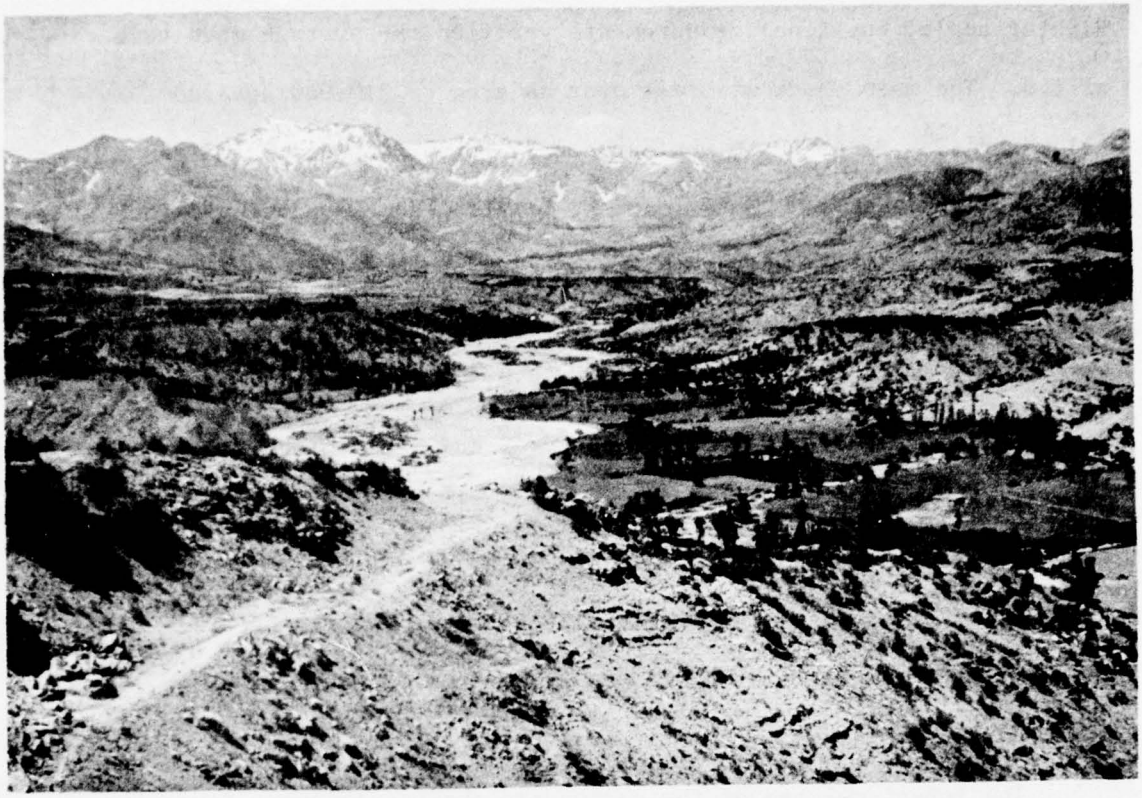

Figure 9. Productive alluvial soils along the Kulp Çayı in northern Diyarbakır province. Notice the dispersed houses in the flood plain.

Richter scale, but final measurements verified the average magnitude at 6.9. The main shock was felt over an area of 210,000 squared kilometers.[14] Focal depth was between 15 to 25 kilometers and the shaking lasted between 20-24 seconds.[15] After-shocks continued for over a month. Smaller after-shocks on 25 September 1975 caused additional damage and several casualties.

Epicenter intensity was assigned VIII by the Turkish Earthquake Research Institute. I agree with Yanev,[16] and would place the intensity of IX Modified Mercalli (MM) near Lice (Table 4). I base this rating on observations of the destruction of the rock ridges overlooking Lice and the many rock slides throughout the area (Figure 10). In addition, there was almost total destruction of most masonry buildings.

The isoseismal map of the earthquake shows a southern direction of spread of intensity (Figure 11). This may be a result of the Bitlis Block terminating just north of Lice.[17]

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[14]Peter I. Yanev, "The Lice, Turkey Earthquake of September 6, 1975 Reconnaissance Report," Newsletter, Earthquake Engineering Research Institute, Vol. 9, No. 6B (November, 1975), p. 7. Also reported in UNESCO, Country Monograph of Turkey, p. 24.

[15]"Statement by the Turkish Delegation on Earthquake at Lice, Turkey," presented to NATO Civil Defense Committee, Brussels, October 15, 1975, Annex C to AC/23-N259, NATO Unclassified, mimeographed, p. 1.

[16]Peter I. Yanev, "The Lice, Turkey Earthquake of September 6, 1975: A Preliminary Engineering Investigation," Earthquake Information Bulletin, Vol. 8, No. 2 (March-April 1976), p. 5.

[17]Lice Depremi Raporu (Lice Earthquake Report), (Ankara: T.C. İmar ve İskân Bakanlığı, Deprem Araştırma Enstitüsü Başkanlığı, 1976), p. 69.

TABLE 4

APPROXIMATE RELATIONSHIPS BETWEEN EARTHQUAKE PHENOMENA

Magnitude	Intensity (MM)[a]	Distance Felt In Miles[b]	Expected Annual Incidence[c]
3.0 - 3.9	II - III	15	49,000
4.0 - 4.9	IV - V	30	6,200
5.0 - 5.9	VI - VII	70	800
6.0 - 6.9	VII - VIII	125	120
7.0 - 7.9	IX - X	250	18
8.0 - 8.9	XI - XII	450	1

[a] C.F. Richter, Elementary Seismology, (San Francisco, W.H. Freeman and Co., 1958), pp. 353, 366.

[b] H. Benioff and B. Gutenberg, "General Introduction to Seismology," Earthquakes in Kern County During 1952, (San Francisco: State of California Division of Mines, 1955), p. 133.

[c] B. Gutenberg and C.F. Richter, Seismicity of the Earth and Associated Phenomena, (Princeton, N.J.: Princeton University Press, 1954), p. 18.

Figure 10. Massive limestone rock slides occurred above Lice. This slide was on the east side of Lice. The cemetery is shown in the bottom left corner.

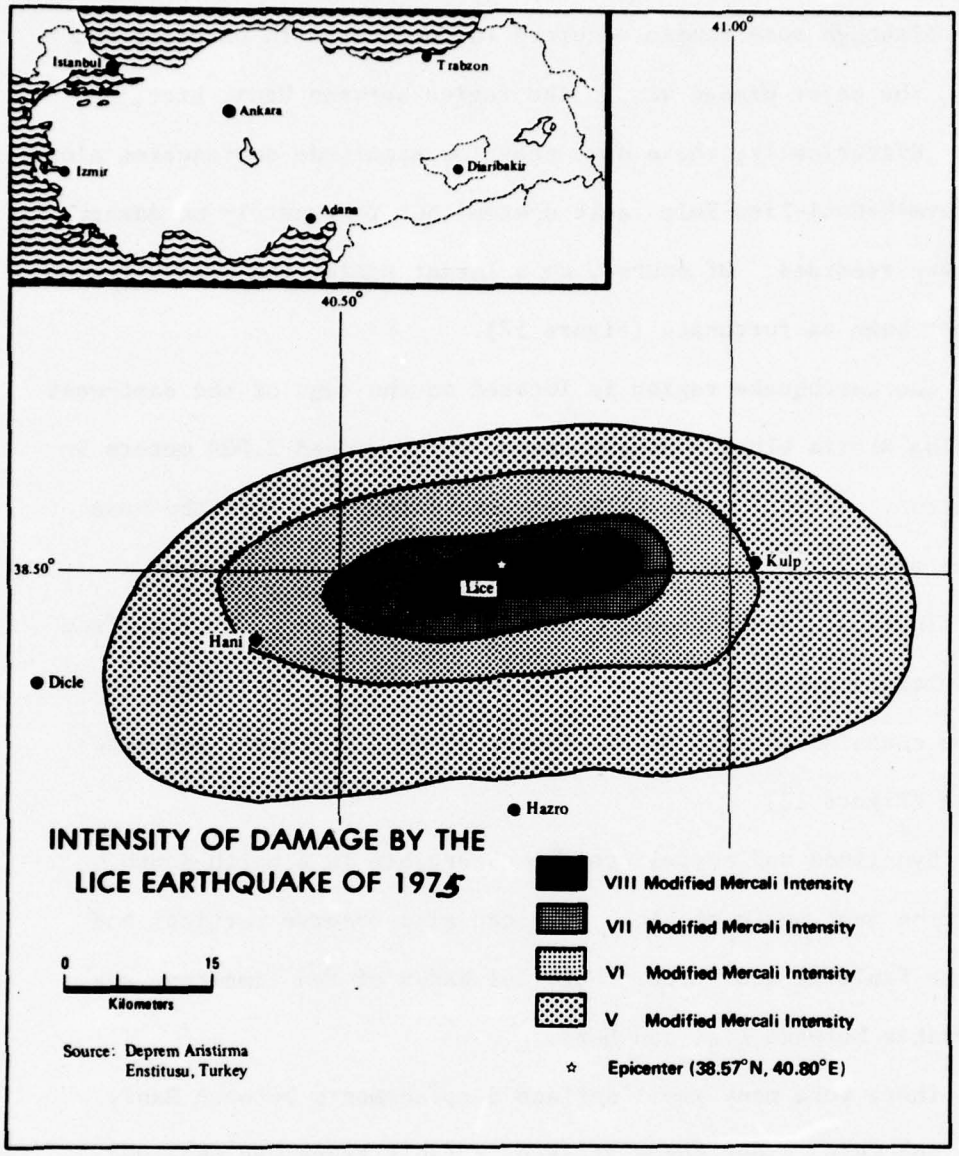
Istanbul
Trabzon
Ankara
Izmir
Diarbakir
Adana
41.00°
40.50°
38.50°
Kulp
Lice
Hani
Dicle
Hazro
INTENSITY OF DAMAGE BY THE
LICE EARTHQUAKE OF 1975
0
15
Kilometers
Source: Deprem Aristirma
Enstitusu, Turkey
VIII Modified Mercali Intensity
VII Modified Mercali Intensity
VI Modified Mercali Intensity
V Modified Mercali Intensity
Epicenter (38.57°N, 40.80°E)

Figure 11

Although some damage occurred in the districts of Dicle and Hazro, the major damage was in the region between Hani, Lice, and Kulp. Historically, there have been low magnitude earthquakes along the Çermik-Hani-Lice-Kulp fault system, but fortunately no damage has been recorded. Of course, on a larger scale, the nearby region has not been as fortunate (Figure 12).

The earthquake region is located on the edge of the east-west trending Bitlis block mountain ranges which exceed 2,000 meters in elevation. Geologically, Paleozoic era formations form the base of the area.[18]

There are also eocene, miocene, and pliocene formations from the Tertiary period widely distributed throughout the area. The region contains formations of limestone, conglomerates, and sandstones (Figure 13).

Synclines and anticlines are observable in a north-south direction just north of Lice. One can also observe vertical and reverse faulting near Lice. Parallel bands of red limestone are observable between Lice and Hani.

There were many small surface displacements between Hani, Lice, and Kulp. Near Korha village, a fault trace was observed crossing the Diyarbakır-Bingol road.[19]

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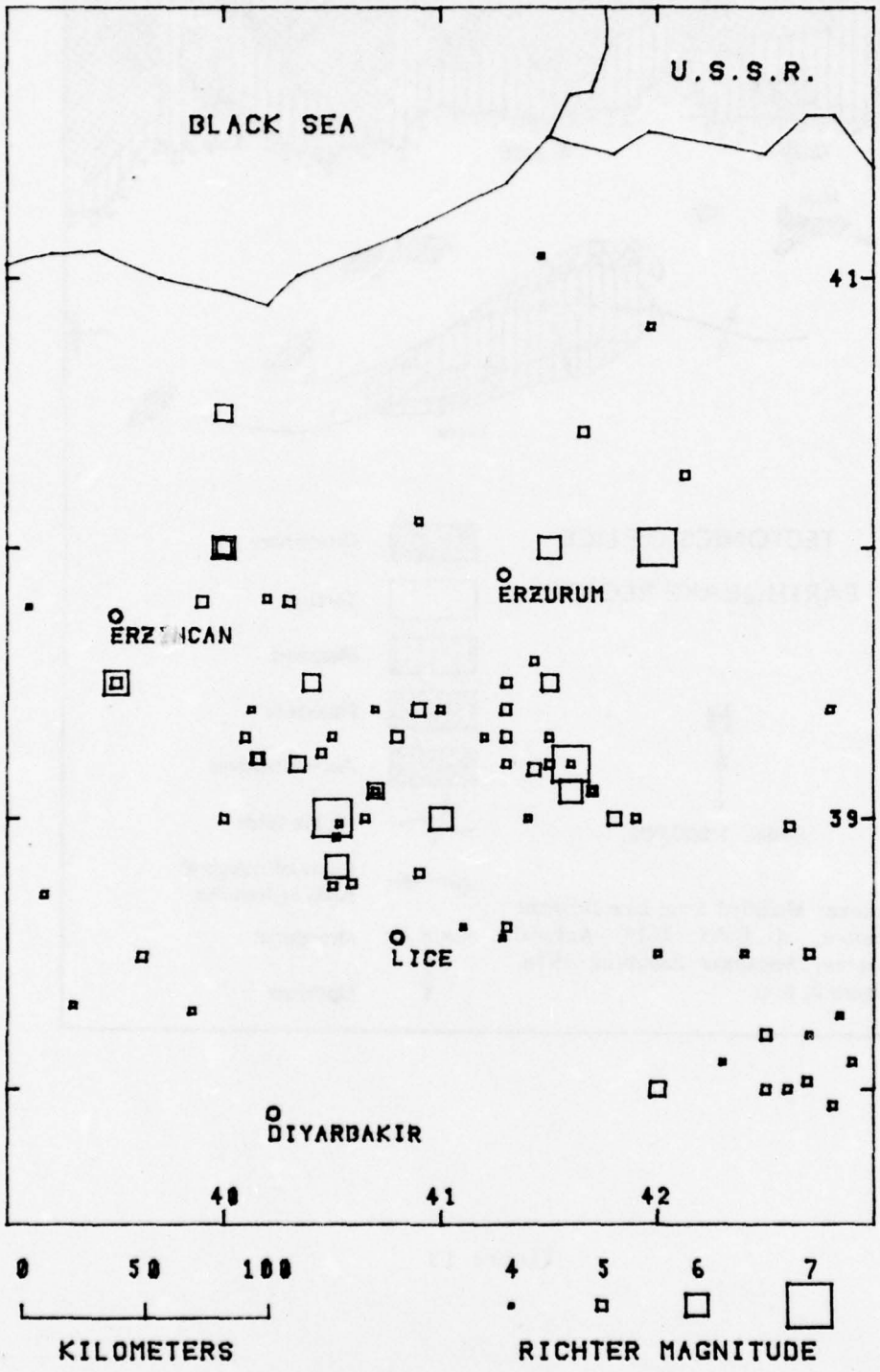
[18] Ibid., p. 67.

[19] Ibid., p. 67.

EARTHQUAKES IN THE LICE AREA: 1900-1974



SOURCE: NATIONAL GEOPHYSICAL AND SOLAR-TERRESTRIAL DATA CENTER

Figure 12

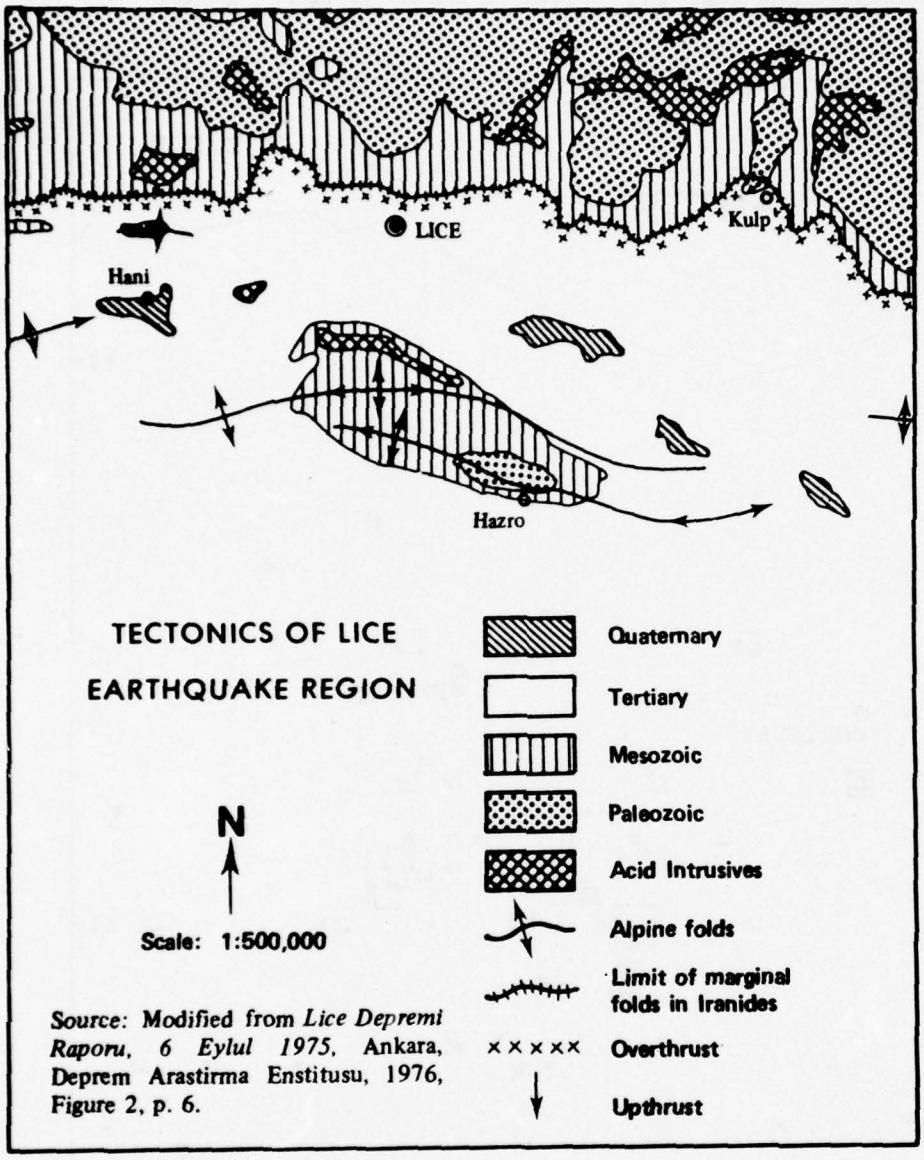

LICE
Kulp
Hani
Hazro
TECTONICS OF LICE
EARTHQUAKE REGION
N
Scale: 1:500,000
Source: Modified from Lice Depremi Raporu, 6 Eylul 1975, Ankara, Deprem Arastirma Enstitusu, 1976, Figure 2, p. 6.
Quaternary
Tertiary
Mesozoic
Paleozoic
Acid Intrusives
Alpine folds
Limit of marginal folds in Iranides
Overthrust
Upthrust

Figure 13

LICE: THE FOCUS OF CATASTROPHE

The town of Lice was situated in rows of terraces on the south side of a steep mountain. The town consisted of 13 sections (mahalle) containing 2,238 houses: Cami Kebir (58); Çarşı (105); Delvan (111); Kali (245); Kalvan (237); Karahasan (261); Kaya (68); Körtük (200); Mirminağa (142); Molla (158); Muradiye (104); Şaar (386); and Yenişehir (163) (Figure 14).[20]

Twenty minutes after the noon hour on Saturday, September 6, 1975, a large percentage of Lice's 8,093 people were in their homes, eating or resting. Many others were walking along Çarşı, Hukumet, Koprubaşı, Cortyol, Kulp, Yenişehir or other streets. Some were working in the two bakeries, in the four mills, in the six barber shops, and in the five hotels. The town's movie would not be open until dark. The public bath was open, as was the post office, telephone and telegraph office. The three elementary and one high school were closed. Some people were eating the noon meal in the various lokantas in Lice. Others were having coffee or tea in one of the seven coffee houses. Still others were washing their face, hands and feet in the mosque washing fountains.

The disastrous shaking began suddenly, with no warning. Large boulders were broken off the top of the mountain and rolled down onto and through the town. The horizontal shaking quickly

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[20] Data provided by Diyarbakır Regional Office, Ministry of Reconstruction and Resettlement.

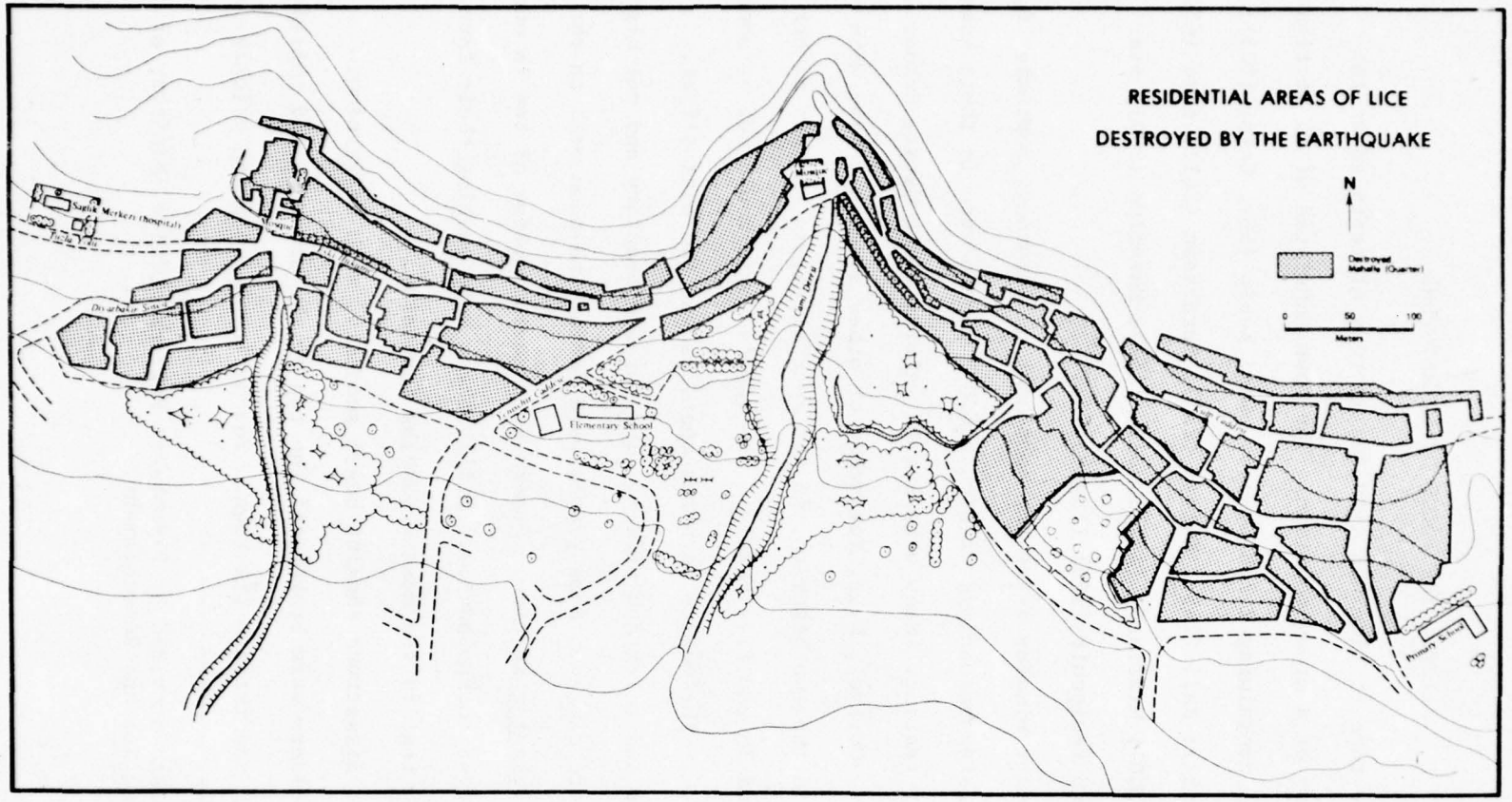
RESIDENTIAL AREAS OF LICE
DESTROYED BY THE EARTHQUAKE
N
Elementary School

Figure 14

collapsed tons of stones, mud, and logs from the roofs of houses, onto the people inside (Figures 15, 16, A1, A2, A3).[21]

The result was awesome. About 1,500 people were killed in Lice.[22] The death toll throughout the disaster area was 2,385, with 3,339 injured. As terrible as the disaster was, it could have been far worse. Obviously, had it been late at night, casualties would have been far greater. Twelve of Lice's mahalles were completely destroyed. The thirteenth, Yenişehir, suffered 21 homes totally destroyed. However, more than houses were destroyed in Lice. Damages included 17 official structures, 132 commercial activities, 6 schools, and 6 mosques.[23]

All of the government and public buildings in Lice were destroyed or badly damaged. Included are the state hospital, located on the western edge of town, the high school, boarding school, gendarmarie building, old municipality building, government houses, and the new municipality building (Figures A4, A5, and A6). Early reports of property damage were estimated by Turkish officials at between seventeen and eighteen million dollars.

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[21]Figures preceded by the letter "A" are included in the Appendix beginning on page 63.

[22]Interview with Halil Akgul, mayor of Lice, June 4, 1976.

[23]Statistics provided by Diyarbakır Regional Office, Ministry of Reconstruction and Resettlement, and observations in Lice.

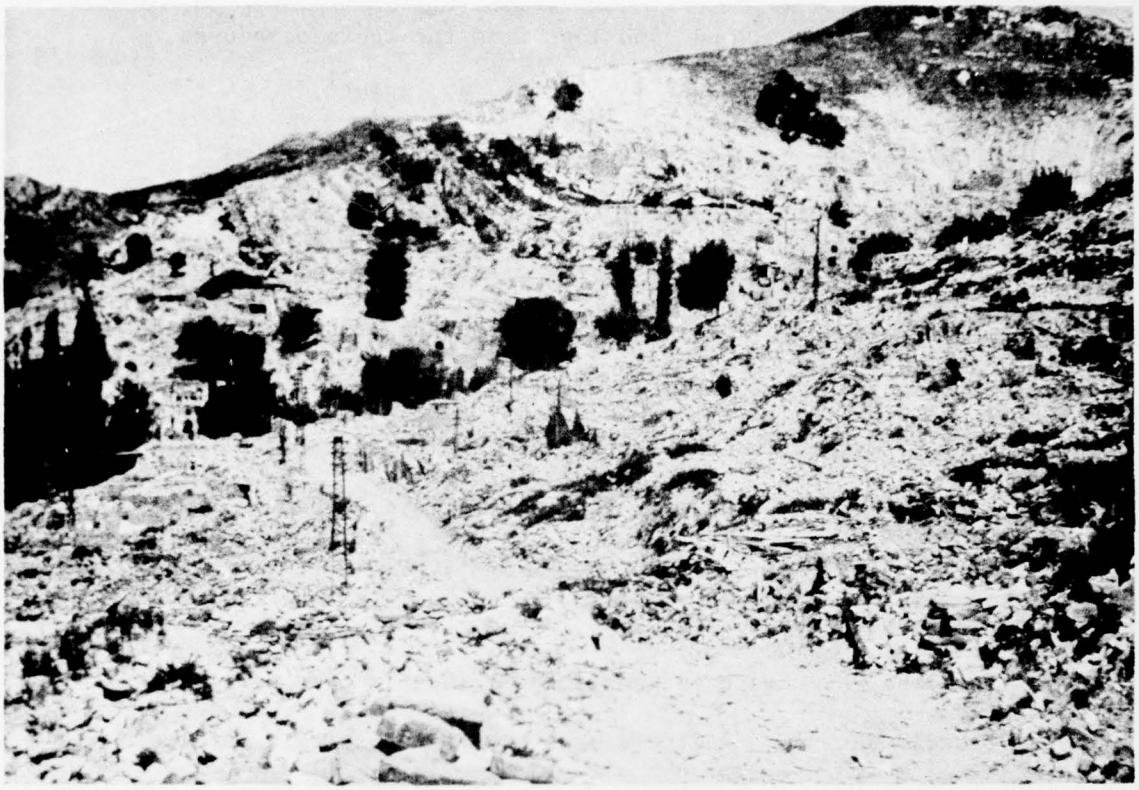

Figure 15. Looking westward from the east side of Lice. The row of trees in the center of the picture are along the Cami valley which divided the town. Rock slides are noticeable at the top of the picture.

Figure 16. Massive destruction in upper Lice.

NATIONAL AND INTERNATIONAL RESPONSE TO THE DISASTER[24]

The series of responses to disasters are well documented for developed nations, but only minimally documented for developing societies.[25] Turkey, as do all developing societies, faces extreme difficulty in coping with the events immediately following an earthquake disaster.[26] However, considering the immense difficulties, Turkey's rescue and relief operations appeared effective and timely.

Thorough advance planning for disaster relief is largely responsible for Turkey's success in speedy implementation of recovery actions immediately after a disaster. Turkey developed an improved plan to effectively organize emergency and relief services after the 1966 Varto earthquake disaster.[27] The plan has proved effective for the Gediz, Burdur, Bingöl, and Lice earthquakes.

The Central Coordinator Committee for Natural Disasters was called into session when the news of the earthquake was relayed from Lice to the Diyarbakır Governor's office to the Ministry of Reconstruction and Resettlement in Ankara. Undersecretaries from the

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[24] This discussion is based on a variety of sources, including verbal accounts by residents of Gediz and Lice and officials in Ankara, Diyarbakır, Lice, Kütahya and Gediz. Also useful was "Statement by the Turkish Delegation on Earthquake at Lice, Turkey" 15 October 1975, Annex C to AC/23-N/259, NATO Unclassified, mimeographed, 7 pages.

[25] For example, see George W. Baker and Dwight W. Chapman (eds.), Man and Society in Disaster (Basic Books, New York, 1962).

[26] Mitchell, "Reconstruction after Disaster...", pp. 303-304.

[27] UNESCO, Country Monograph of Turkey, pp. 51-52.

Ministries of Reconstruction and Resettlement, the Interior, Health, Defense, and the Director of the Turkish Red Crescent (Red Cross) were called into session. While the Central Coordinator Committee was convening, the Diyarbakır Provintial Relief Committee, headed by the governor and consisting of the Diyarbakır mayor, gendarmarie commander, secretary of civil defense, chief of police forces, red crescent director and the military forces commander, was implementing emergency plans for immediate rescue and relief for the victims. Urgent actions are necessary in any disaster, and the reaction to the Gediz disaster saved many lives. Similar urgent actions were reportedly repeated in Lice.

The Diyarbakır Provintial Relief Committee established sub-committees for emergency rescue and ruin removal, tent distribution, health affairs, food distribution, evaluation of damage, and security. The sub-committees carried out their functions in Lice, Hani, Kulp, and other damaged settlements.

Military personnel arrived in the area about three hours after the disaster and began rescue operations. A helicopter shuttle was established between a central storage point in Diyarbakır and an area near Lice. Helicopters also brought vital assistance to the scores of isolated villages in the region.

Immediate attention was focused on rescue, medical care, shelter, and food. Ambulances, taxis, trucks, and private cars jammed the road to Lice, trying to get into the area to provide assistance in rescue

efforts. An army engineering batallion brought in cranes, bulldozers and graders to clear the debris and assist in searching for survivors. On the day of the earthquakes the Prime Minister and Minister of Reconstruction and Resettlement visited the area.

After the immediate rescue phase, the government's main objective was to provide permanent housing for the survivors. Before construction could begin it was necessary to evaluate the damage. The Earthquake Research Institute of the Ministry of Reconstruction and Resettlement did the evaluation, with assistance from Ankara and Istanbul university departments. The Ministry visited settlements and classified damage to houses and buildings as: not damaged; lightly damaged; moderately damaged; heavily damaged or destroyed. Based on this classification, an individual would be able to claim aid and new housing assistance.

If a settlement could be restored safely and economically on its original site, it usually was. If the original site was declared geologically unsafe, the settlement was rebuilt on a new location. Lice was declared unsafe and a new site was chosen after the Department of Geological Investigations, General Directorate of Natural Disasters Affairs, conducted geological soundings and soil tests in the new area.

Private construction contractors sometimes construct villages, and even when construction is carried out by the Ministry of Reconstruction and Resettlement, much of the project can be subcontracted. This is especially true of the public facilities such as roads, water lines and wells, and electricity and sewage facilities.

Construction bids from private industry are usually received by government officials when an entire village or town must be rebuilt. In many cases, the Ministry of Reconstruction and Resettlement constructs the new settlements (Table 5). The individual who receives a new home is usually required to accept a 20 year no (or very low) interest loan. Sometimes the debt is cancelled after a short period of time, depending on the individual's ability to pay.

Three days after the disaster, the Turkish government appropriated about 34 million dollars (500 million Turkish Lira) for rehabilitation and reconstruction. This compares to 50 million dollars after Gediz, 25 million after Burdur, and 28 million after Bingol.[28]

International assistance was prompt and extensive.[29] A total of 14,837,058 dollars in assistance was received by Turkey from private and government foreign sources (Table 6). The United States, through its Ambassador to Turkey, donated an amount equivalent to 25,000 dollars to the Turkish Red Crescent on 9 September 1975. The U.S. Office of Foreign Disaster Assistance, Agency for Inter-

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[28] William A. Mitchell and Edward A. Glowatski, "Some Aspects of the Gediz (Turkey) Earthquake, March 28, 1970." Journal of Geography, Vol. LXX, No. 4, April 1971, p. 229; W.O. Keightley, Destructive Earthquakes in Burdur and Bingol Turkey, May 1971, Report submitted to the Committee on Natural Disasters, NRC (Washington, D.C.: National Academy of Sciences, 1975), p. 1.

[29] This paragraph is based on tentative data provided by the Office of U.S. Foreign Disaster Assistance, Agency for International Development, Department of State, August 12, 1976.

TABLE 5

TURKISH SUPPLIED HOUSE TYPES[a]
(Ministry of Reconstruction and Resettlement)

District	Village	Houses Scheduled	Houses Completed
LİCE	City	1,615	1,615
	Budak	43	0
	Kıpçak	139	75
	Kıyı	60	30
	Sığnak	44	44
	Dallıca	31	10
	Baharlar	58	42
	Yorulmaz	75	16
	Dibek	83	83
	Bekirhan	29	29
	Ecemiş	87	0
HANİ	Okur	42	0
	Topçular	51	51
	Gürbüz	223	155
	Ahil	40	22
	Kirim	49	49
	Süslü	22	0
	Kalaba	77	27
	Marık (Seren?)	14	0
KULP	Kaynak	20	0
	Elmalı	32	0
	Bozova	20	0
	Altay	30	1
	Kocaalan	45	0
HAZRO	City	100	0
Total		3,029	2,249 (74%)

[a]Provided by T.C. İmar ve İskân Bakanlığı, Bölge Müdürlüğü, Diyarbakır, Turkey (Diyarbakır Regional Director, Ministry of Reconstruction and Resettlement), June 1976.

TABLE 6

INTERNATIONAL ASSISTANCE FOR THE LICE DISASTER
(Government and Red Cross Societies)[a]

Country	Assistance	Country	Assistance
Afghanistan	$ 3,035	Libya	$1,000,000
Australia	3,003	Luxembourg	13,941
Belgium	84,877	Monaco	1,124
Brazil	1,012	Netherlands	529,711
Bulgaria	57,600	New Zealand	2,102
Canada	47,097	Norway	70,731
Peoples Republic of China	51,592	Pakistan	994,384
Denmark	32,121	Poland	4,856
France	19,282	Romania	112,482
Dem. Republic of Germany	10,739	South Africa	813
Fed. Republic of Germany	129,220	Saudi Arabia	10,000,000
Greece	3,649	Spain	4,349
Iran	129,910	Sweden	72,407
Italy	110,840	Switzerland	461,518
Ireland	964	Taiwan	21,468
Japan	16,896	Thailand	256
Jordan	780	Tunisia	1,263
Republic of Korea	10,939	United Arab Emirates	9,995
Kuwait	503,407	U.S.S.R.	19,180
Liechtenstein	375	United Kingdom	37,406
		United States	258,892
		Yugoslavia	2,862
			$14,837,058

[a]Calculated from tentative data provided by Office of U.S. Foreign Disaster Assistance, Agency for International Development, Department of State, August 12, 1976.

national Development, assisted by providing a grant of 200,000 dollars to Turkey through the League of Red Cross Societies. The U.S. government also paid part of the transportation cost of materials and equipment donated to Turkey by the London OXFAM organization for construction of 800 polyurethane "igloo" style shelters in the disaster area (Figure A7). Total value of the U.S. government contributions was 258,892 dollars.

THE NEW TOWN OF LİCE

On 11 September, just five days after the disaster, a geological investigation was completed by Earthquake Research Institute officials and a new site for Lice was chosen. The new location is about two kilometers south of the old city, and unlike in Gediz,[30] practically all the residents live in the new city.

Fifty-four days after the disaster, on 29 October, 1,568 houses had been built. In addition, 40 shops, an elementary school, a mosque and a bakery were also finished. The new town's infrastructure included 28 kilometers of stabilized streets, 901 electric power poles, 32,050 meters of electric power lines, and 22,463 meters of water and sewage lines.[31]

Ten months after the earthquake Lice was almost completed (Figures 17, A8, and A9). Final plans were for a total of 2,327 homes,

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[30] Mitchell, Turkish Villages After an Earthquake..., p. 88.

[31] Yeni Lice: 6 Eylül-29 Ekim Lice Depremi, Türk Devletinin Gücü ile Cumhuriyet Hükümetinin 54 Günde inşa ettiği (Ankara: no publisher, 1975), p. 15.

Figure 17. A view of new Lice from the ruins of the old town.

12 bakeries, 4 mosques, 6 coffee houses, 1 public bath, 192 shops, a high school, and an elementary school (Figure A10).[32] For recreation, the town plans are for a green belt and a sporting complex. New Lice is planned for an eventual population of 20,000.

Several official buildings have been built along the newly asphalted Lice-Kulp road north of new Lice. These include three buildings for: (1) Adliye; (2) T.C. Lice Kaymakamlığı; and (3) T.C. Askelık Şubesi Başkanlığı.

The new houses in Lice are constructed under the auspices of the Ministry of Reconstruction and Resettlement. They have wood-framed, pre-fabricated wall panels of cement board covering a layer of insulation, and either corrugated steel or tile roofs (Figures A11, A12, A13, A14, A15, A16, and A17). These houses have been described in detail by Mitchell for the Gediz earthquake of 1970 (Figure A18, A19, and A20) and by Keightly for the Bingol disaster of 1971.[33] The Bingol and Lice earthquakes tested the earthquake resistence of these houses under strong earthquake intensity. No damage was reported for the new 88 homes in Bingol. In Lice, the 150 earthquake-resistent homes built along the Lice-Kulp road, after the rockslide several years ago, suffered minimum damage and most

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[32]Interview with Halil Akgül, mayor of Lice, 4 June 1976 and Yeni Lice: 6 Eylül-29 Ekim. Records of the İmar ve İskan Bakanliği, Bölge Mudurlugu, Diyarbakır, indicate that a total of 1615 homes would be built in Lice, and that all have been completed.

[33]Mitchell, Turkish Villages After an Earthquake..." Chapters III and V, and W.O. Keightley, Destructive Earthquakes in Burdur and Bingöl, Turkey, May 1971, p. 77.

remained occupied after the earthquake (Figures A21 and A22). Some houses had fallen and cracked plaster, and dislocated roof tiles, but none had severe structural damage.

HOUSE CONSTRUCTION IN RURAL TURKEY

Approximately 61.2 percent of Turkey's population lives in 3.9 million rural homes.[34] These homes are built of: (1) stone and brick masonry (48%); (2) adobe construction (28%); (3) timber frame (13%); or (4) mixed with the preceding and other hybrid types (11%).[35] Almost all are one- or two-story.

Construction practices in Turkey vary between and within regions depending on local materials and skills that have been passed down from older generations. For example, there are four basic types of village construction used in the Gediz region (1970 western Turkey earthquake): (1) cobble (fieldstone) or adobe wall-bearing; (2) braced frames of handhewn timber frame (or round posts); (3) tile or brick walls; and (4) reinforced concrete. The majority of homes in this region are of timber frame construction, one to two stories high, and walled with stones or bricks. Although many roofs are of tile, many are also flat mud roofs, often as much as 40 centimeters thick.[36]

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[34] UNESCO, Country Monograph of Turkey, p. 26.

[35] Ibid., p. 28.

[36] Mitchell, "Reconstruction After Disaster...", pp. 304-309.

In the Varto region of eastern Turkey (1966 earthquake), the traditional dwellings consist of houses with adobe brick and cobblestones or unshaped basalt blocks. As described by Wallace, very few cobble or fieldstone houses survived the Varto disaster, and most casualties were from the collapsed roofs and walls of heavy materials.[37] In the Bingol area (1971 earthquake), most of the construction is similar to that in the Varto region. The walls are made of broken pieces of basalt, held together by mud or small stones keyed in between larger ones.[38] Heavy roofs and walls contributed most to the casualties.

Houses in the Lice area, as in many others of Turkey, are made of cobblestone, held together with mud mortar, and topped with a flat earth roof which may later support part of another level of houses (Figure A23). Official government buildings are either brick or stone masonry, held together with lime mortar. There were very few reinforced concrete structures in the area before the earthquake.

The typical house in the earthquake region invited catastrophe (Figure A24). The cobblestone walls have little shear strength and the heavy earth-covered roofs are not properly connected to the walls. Walls and roofs are almost independent except for the contact

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[37]Robert E. Wallace, "Earthquake of August 19, 1966, Varto Area, Eastern Turkey," Bulletin of the Sismological Society of America, Vol. 58, No. 1 (1968), pp. 38-40.

[38]W.O. Keightley, Destructive Earthquakes in Burdur and Bingol, Turkey, May 1971, pp. 12-13.

exerted by gravity. Consequently, all the houses in old Lice (excluding the mahalle of Yenişehir--or "new city") were totally destroyed.

VILLAGE RECONSTRUCTION

Lice town was the focus of catastrophe, but there was spectacular destruction in many villages. For example, rock falls onto Yamac[39] and complete collapsing of houses in Yünlüce, Kıpcak, Karpuzlu, Damar, and Gürbüz clearly reflected the intensity of the earthquake and the poor quality of houses and construction techniques.

A total of 5,555 houses in 188 villages were completely or heavily damaged. Three thousand seven hundred and eighty-three villages were moderately damaged, and 4,664 village homes received light damage (Figures A25, A26, A27, and A28).[40] A total of 5,805 houses are scheduled for construction (Table 7).

The two pre-fabricated house factories in Ankara, producing at maximum capacity, were considered capable of completing 1,500 houses for the Lice restoration by the middle of November. Since far more were needed before winter would begin, the Turkish government decided to import houses from European countries. Thus, there are more different types of structures in the disaster region than

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[39] Lice Depremi Raporu, pp. 67-68.

[40] Unpublished data furnished by the Diyarbakır District Office, Ministry of Reconstruction and Resettlement, Diyarbakır, Turkey, on 9 June 1976.

TABLE 7

TOTAL HOUSE CONSTRUCTION
FOR THE LİCE DISASTER REGION[a]

District	House Construction Scheduled		Houses Completed	
	Foreign Assisted	Turkish Gov't.	Foreign Assisted	Turkish Gov't.
DİCLE	736	95	75	1
HANİ	0	518	374	304
HAZRO	97	100	0	0
KULP	541	52	129	0
LİCE	1,402	2,264	1,073	1,944
Subtotals	2,776	3,029	1,651	2,249
Total	5,805		3,900	(67%)

[a]Construction by Turkish Government and Foreign Assisted (as of 1 June 1976). Provided by T.C. İmar ve İskan Bakanlığı, Bölge Müdürlüğü, Diyarbakır, Turkey (Diyarbakır Regional Director, Ministry of Reconstruction and Resettlement), June, 1976.

observed after any previous disaster (Table 8). Finland, France (Figure A29), Germany, (Figure A30), Libya (Figure A31), Switzerland and Yugoslavia (Figure A32) have exported houses with distinctive characteristics. Seven hundred and four French style houses in 15 villages have been completed; 377 more are scheduled. Seven hundred and ninety-five Yugoslavian styles are planned for 21 villages, but only 335 have been completed. Finland has already built 250 in Hani. Approximately 46 percent of the planned 2,776 houses built with foreign assistance have been completed (Table 7). In addition, several social facilities have been completed (Table 9).

Yünlüce: A Swiss Supported Village

Yünlüce village is now very distinctive compared to other restored settlements (Figures 18, A33). The Swiss Disaster Relief Organization of the Swiss government, in cooperation with the Republic of Turkey, selected Yünlüce for rebuilding as a model "Swiss" village. A Swiss survey team visited the disaster area from 29 September to 4 October 1975 and selected the new village site, about 600 meters south of the old village. Between 15 October 1975 and 26 November 1975, fourteen Swiss construction engineers, working with Turkish laborers from Yünlüce, completed 50 houses which were immediately occupied. (Figures A34 and A35).

In June 1976, construction was almost completed. The new village, with a Swiss and Turkish flag displayed side-by-side at the southwest entrance, contains an elementary school with three grades,

TABLE 8

FOREIGN SUPPLIED HOUSE TYPES[a]

District	Village	Houses Scheduled	Houses Completed	Country
DİCLE	Yokuşlu	99	75	Yugoslavia
HANİ	City	250	250	Finland
	City	90	50	France
	City	188	60	Yugoslavia
	Gomerç	21	0	Yugoslavia
	Seren	88	14	France
HAZRO	Dadaş	97	---	France
KULP	City	96	---	Yugoslavia
	Karpuzlu	92	---	Yugoslavia
	Güllük	26	---	Yugoslavia
	Dürü	47	---	Yugoslavia
	Narlıca	122	100	Yugoslavia
	Zeyrek	49	---	Yugoslavia
	Bayır	30	---	Yugoslavia
	Ağaçlı	49	---	Yugoslavia
	Çağlayan	30	0	Yugoslavia
LİCE	Gürbeyli	70	70	France
	Damar	13	13	France
	Tuzla	56	28	France
	Ergin	72	51	France
	Duru	135	53	France
	Daralan	122	117	France
	Yazı	32	32	France
	Boyunlu	102	42	France
	Çavundur	46	46	France
	Arıklı	16	16	France
	Çağdaş	50	50	France
	Kumluca	150	140	France
	Guclu	32	32	France
	Yaprak	127	127	Libya
	Yünlüce	50	50	Switzerland
	Kıralan	65	65	Yugoslavia
	Dernek	181	121	Yugoslavia
	Ceper	83	20	Yugoslavia
Totals		2,776	1,651	

[a]Provided by T.C. İmar ve İskan Bakanlığı, Bölge Müdürlüğü, Diyarbakır, Turkey (Diyarbakır Regional Director), Ministry of Reconstruction and Resettlement), June, 1976.

TABLE 9

FOREIGN SUPPLIED SOCIAL FACILITIES[a]

District	Village	Facilities	Country
DICLE	Yokuşlu	1 primary school	Yugoslavia
KULP	City	1 primary school	Germany
	City	1 hospital	Germany
	City	1 lodge	Germany
LİCE	Yaprak	1 primary school	Libya
	Yünlüce	1 primary school	Switzerland

[a]Provided by T.C. İmar ve İskan Bakanlığı, Bölge Müdürlügü, Diyarbakır, Turkey (Diyarbakır Regional Director), Ministry of Reconstruction and Resettlement), June, 1976.

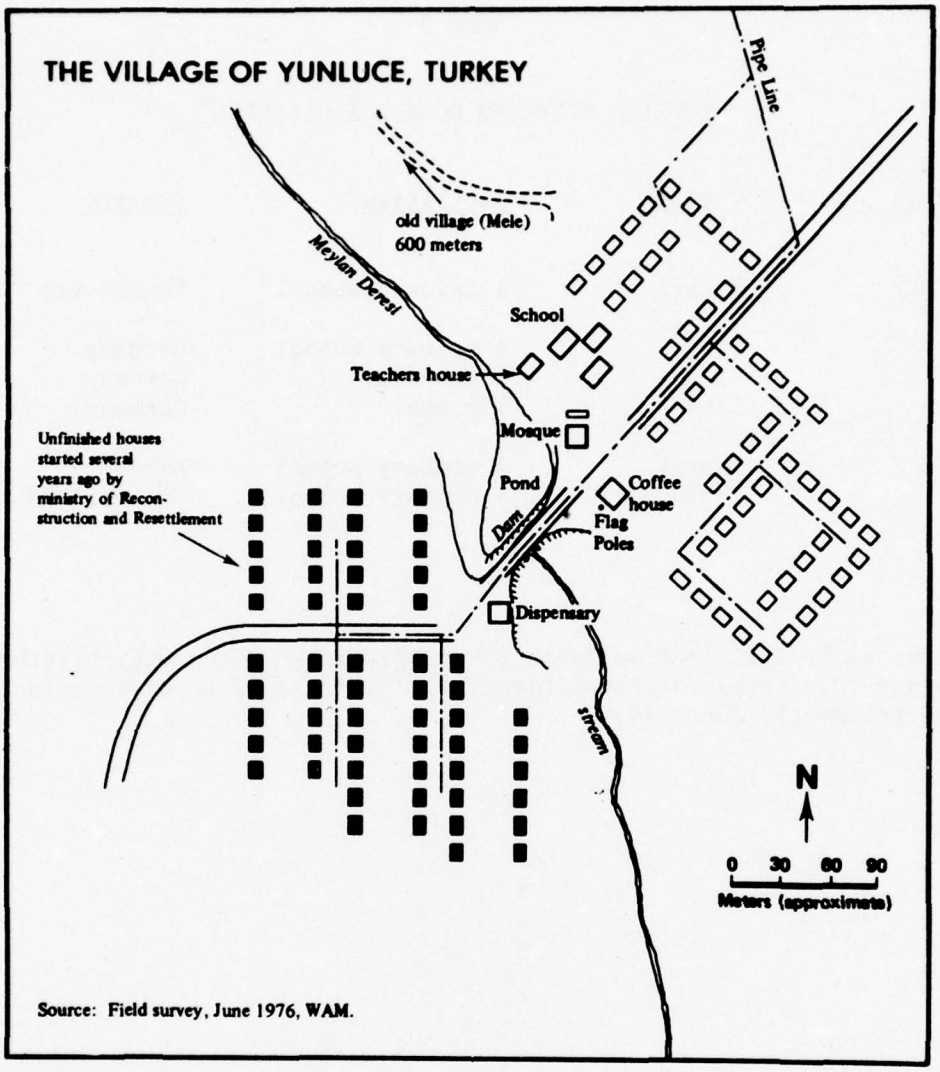
THE VILLAGE OF YUNLUCE, TURKEY
Pipe Line
old village (Mele)
600 meters
Meylan Deresi
School
Teachers house
Mosque
Unfinished houses
started several
years ago by
ministry of Recon-
struction and Resettlement
Pond
Dam
Coffee
house
Flag
Poles
Dispensary
stream
N
0 30 60 90
Meters (approximate)
Source: Field survey, June 1976, WAM.

Figure 18

a teachers' home, a coffeehouse, mosque, medical dispensary, six wash houses, and 50 toilets (Figure A36).

The Swiss realized the problem of separating the villager from his animals and are constructing 150 animal shelters. Also, since the village is about 2,000 meters from a reliable water source, a storage facility has been built at the spring site and water is being piped down by gravity flow. Pressure is quite good, since the relief drops 300 feet over the horizontal distance.

The few villagers I was able to interview expressed pleasure with their new village. The new white colored homes with brown Swiss window shutters and bright green colored sheet steel roofs make a remarkable contrast with the semiarid landscape. Unfortunately, it is doubtful that Yünlüce will have electricity in the foreseeable future.

The expense to the Swiss government for materials, labor, and transportation for the 50 houses was 966,500 Swiss francs.[41]

The Germans, who were constructing a school, hospital, and several houses in Kulp, could learn from the Swiss experience. The Germans were very concerned that the finished product be immaculate. For example, tile floors in the kitchens were cleaned and waxed; although houses already had been painted, a second and third coat were planned. General cleaning efforts by the Germans exceeded that observed during the Gediz reconstruction and that of all other observed Lice settlements. Rigorous use of facilities will quickly

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[41] Interviews with Knut Wiese and Berhard Tschumi in Yunluce Village, 2 June 1976.

erase the effects of immaculate cleaning, second and third coats of paint, waxed floors, and highly polished indoor plumbing fixtures. The additional money spent on niceties could be used to furnish the hospital or the school. Or, the money could be used to defray the cost of bringing water into the houses. The houses had plumbing installed, but were not connected to any sewage or water lines (Figure A37). Based on the Gediz experience, it is unlikely that a majority of the new houses will ever have indoor water.

Yaprak: A Libyan Supported Village

New Yaprak village is located on the road between Lice and Kulp, about 10 kilometers east of Lice (Figure A38). The Libyan government donated an amount approximately equal to one million U.S. dollars for building the new village of 127 homes. During my visit to Yaprak the homes were almost completed. The uniqueness of this village is that a water storage tank was built and pipes laid along with the construction of houses. The village is expected to be the first in the region with operating indoor plumbing.[42] One hundred and fifty families were scheduled to move into the village by the end of June 1976.

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[42] Interview with Mr. Birsel, Yaprak architect in Yaprak village, on 6 June 1976.

CONCLUSION

Restoring an earthquake devastated area is an enormous task. There are bound to be problems when outside agencies attempt to restore communities. The government of Turkey is well experienced with the disruptions caused by earthquake disasters, and makes practical and sincere efforts to minimize the consequences.

Complaints concerning new village houses constructed after the Gediz disaster have been surveyed and reported elsewhere.[43] Although I was unable to apply the Gediz questionnaire in the Lice area, I did observe that most of the earlier recommendations concerning physical arrangements of new villages, quality control of construction, indoor plumbing, water, animal shelters, and glass windows were not implemented.[44] Consequently, as in the Gediz case, research in the Lice disaster area in 1979 or 1980 may reveal that many houses have been abandoned, and that villagers have returned to either their original or other villages.

A basic question concerns the introduction of modern conveniences (high level technology) into the traditional society of the Lice village areas. A somewhat simpler approach (lower level of technology) probably would be more practical and acceptable by the villagers. For example, why include water faucets, sinks, shower stalls, and indoor toilets if there is an extremely low probability that the

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[43] Mitchell, "Turkish Villages After an Earthquake...", Chapter V.

[44] Mitchell, "Turkish Villages After an Earthquake...", Chapter V, and Mitchell, "Reconstruction After Disaster...", pp. 310-313.

house will ever have running water? Need houses be wired for electricity in economically depressed regions that have no electrical infrastructure within reasonable proximity? Considering the unavoidable rigorous use of the houses, do village houses need two or three coats of paint? Are new villages physically arranged as the villagers prefer?

The cost of the restoration program could be significantly reduced and the effectiveness of the resettlement program improved. One way to do this is to modify the present program to include an objective assessment of each damaged village in terms of short term availability of electricity and water. The Gediz study suggests that construction based on future availability of water and electricity is not realistic. Thus, damaged villages that had no electricity, and are not relocated close to electrical power lines, could be rebuilt without electrical fixtures and wiring. Since electricity is required to pump water indoors, the new earthquake resistant houses could also omit water faucets, sinks, shower stalls and indoor toilets. Thousands of new houses have been built since the late 1960's. Small savings from each house unit become significant at this scale of reconstruction. Savings could be reinvested in the construction of village roads.

More emphasis should be placed on restoring traditional homes with improved construction methods to minimize the hazard of horizontal shaking. The Ministry of Reconstruction and Resettle-

ment is making some headway in this direction as evidenced by their rural educational programs on hazard minimization.[45]

[45]Education of the public in earthquake resistant construction methods is a project developed and implemented by the Earthquake Research Institute of the Ministry of Reconstruction and Resettlement. The program involves preparation and distribution of posters and handbooks that illustrate in simple steps how to build an earthquake resistant house with minimal increased cost. There also are regional seminars, courses and conferences scheduled for towns throughout Turkey.

APPENDIX A

LIST OF FIGURES

Figure A1. Typical uncemented adobe construction. The few logs and poles which were used for ceiling supports have been removed.

Figure A2. Although no one lives in old Lice, former residents still walk through the ruins and visit their old home-sites. Note the damaged minaret in the center.

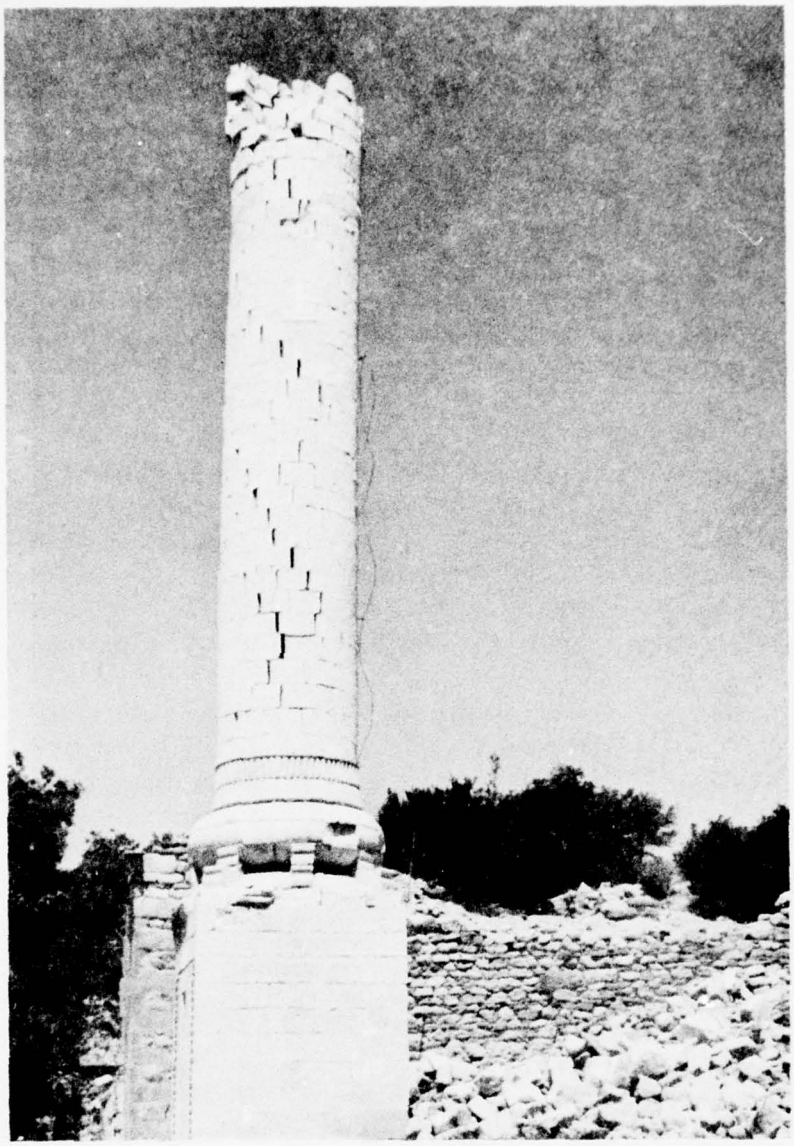


Figure A3. A close up of the minaret from Figure 18 above. The tile blocks are separated by several centimeters.

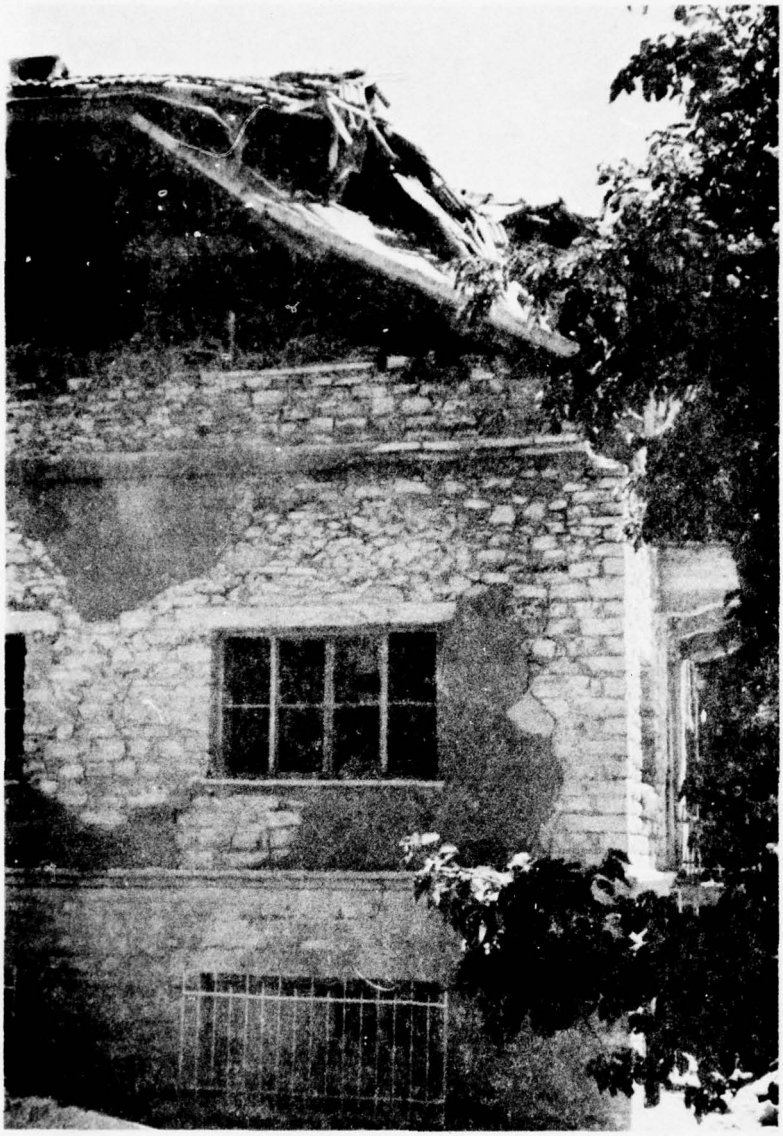


Figure A4. A heavily damaged government masonry building in Lice.

Figure A5. A completely ruined high school building in Lice. Notice the sunken tile roof. A new school has been constructed in the new town.

Figure A6. The completely destroyed police building in Lice.

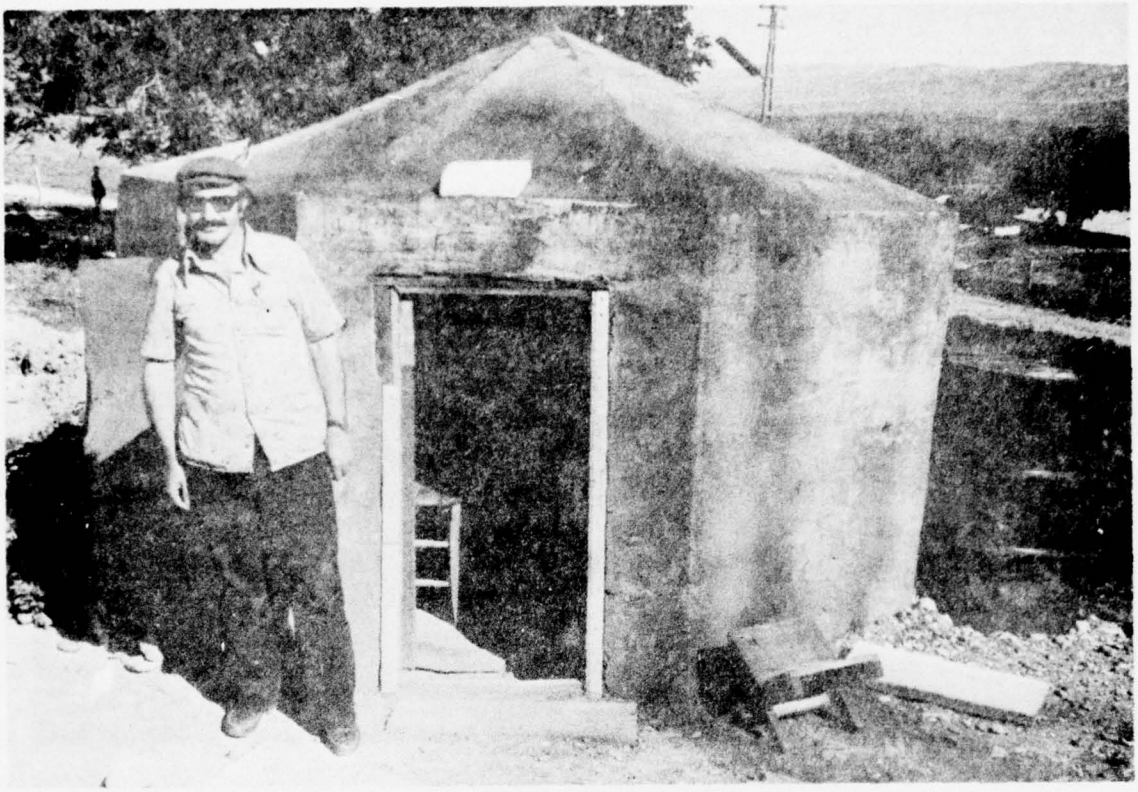


Figure A7. One of the some 800 polyurethane "igloo" shelters distributed in the disaster area.

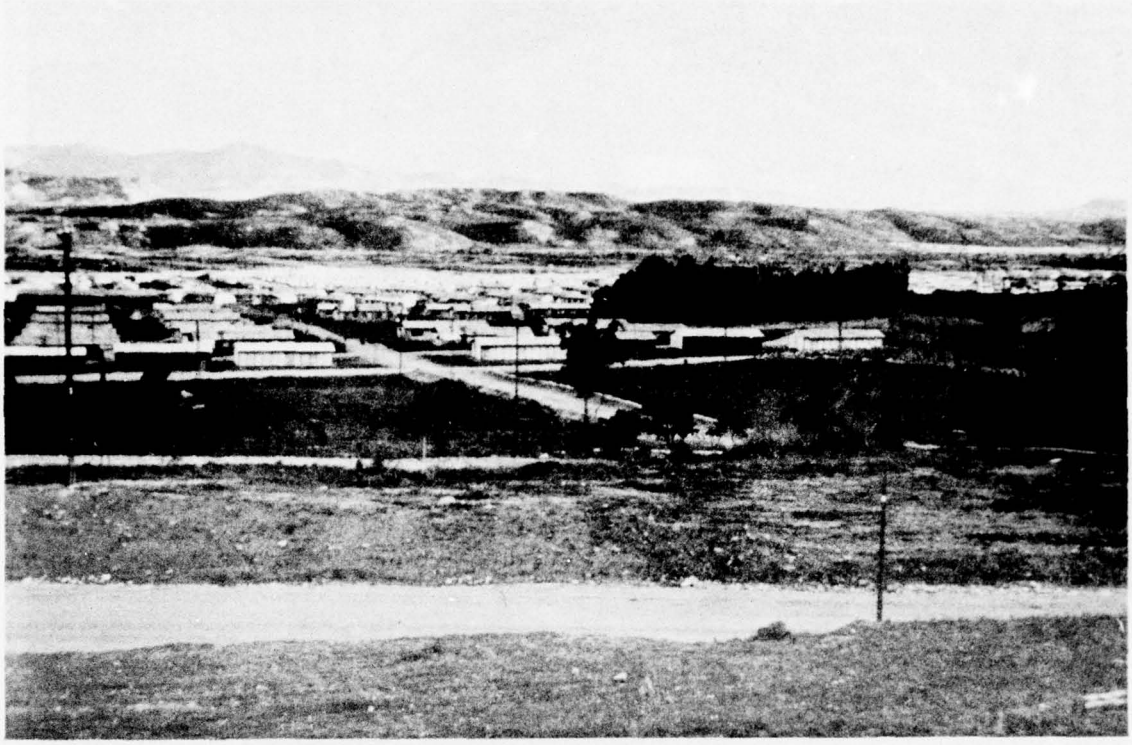


Figure A8. The new town of Lice. The road in the foreground connects Lice with Kulp.

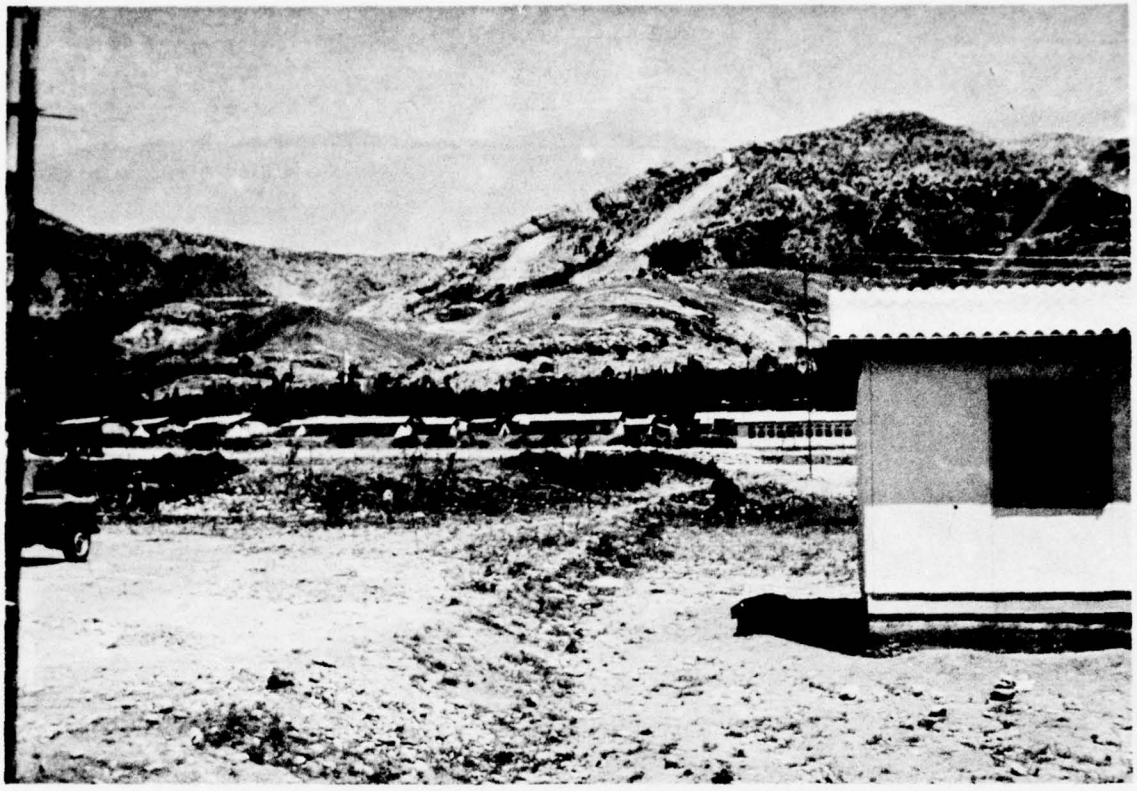


Figure A9. Looking toward old Lice from the new town. The light areas on the mountains are rock slides caused by the earthquake. Notice the large window in the new house.

Figure A10. The new high school in Lice. The school yard is a popular soccer area.

Figure A11. These new duplexes in Lice have large glass windows and electricity. Some may have water soon.

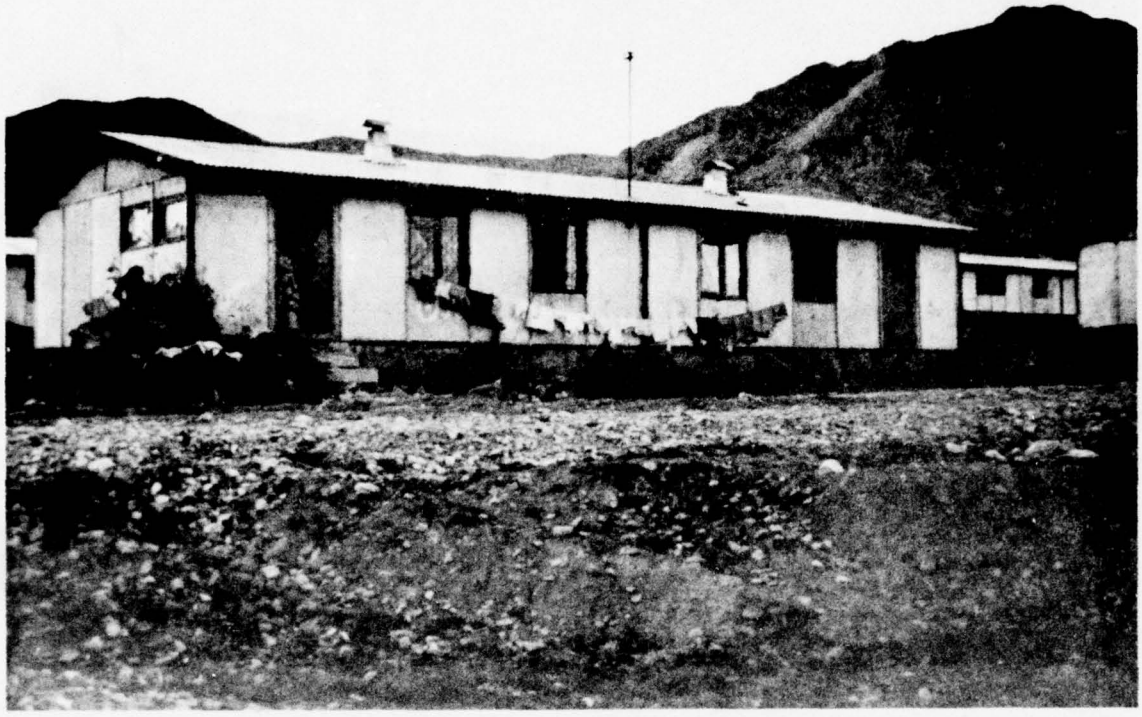


Figure A12. One of the hundreds of new duplexes. Notice the rockslide in the upper right area.

Figure A13. A close up of a new duplex. The house appears much older than its nine months. The concrete foundation has a large hole, the prefabricated wall has been punctured and the corrugated roof is loosely attached in several places.

Figure A14. This man has added a small store to his house in new Lice.

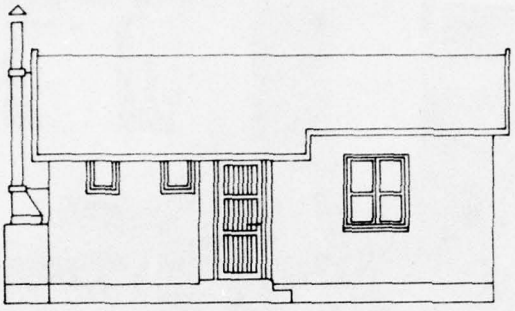
Figure A15. It is common practice to add storage areas onto the new houses. Another rockslide can be seen on the left.

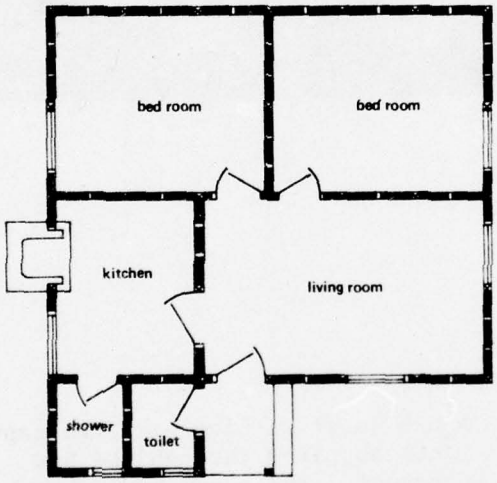
Figure A16. New Lice has wide streets and the houses are evenly spaced with several yards between each unit.

Figure A17. A new house in Lice with two canvas tents supplied through the Red Crescent. The scrub brush has been collected for heating fuel.

HOUSE PLANS FOR NEW VILLAGE HOMES

(Most Popular Type)





SOURCE: KÜTAHYA DEPREM İCRA HEYETI BASKANLIK, 1973

scale: 1:100

Figure A18


HOUSE PLANS FOR NEW VILLAGE HOMES
(Second Most Popular Type)
bed room
living room
kitchen
bed room
toilet
shower
SOURCE: KÜTAHYA DEPREM İCRA HEYETİ BAŞKANLIK, 1973
scale: 1:100

Figure A19

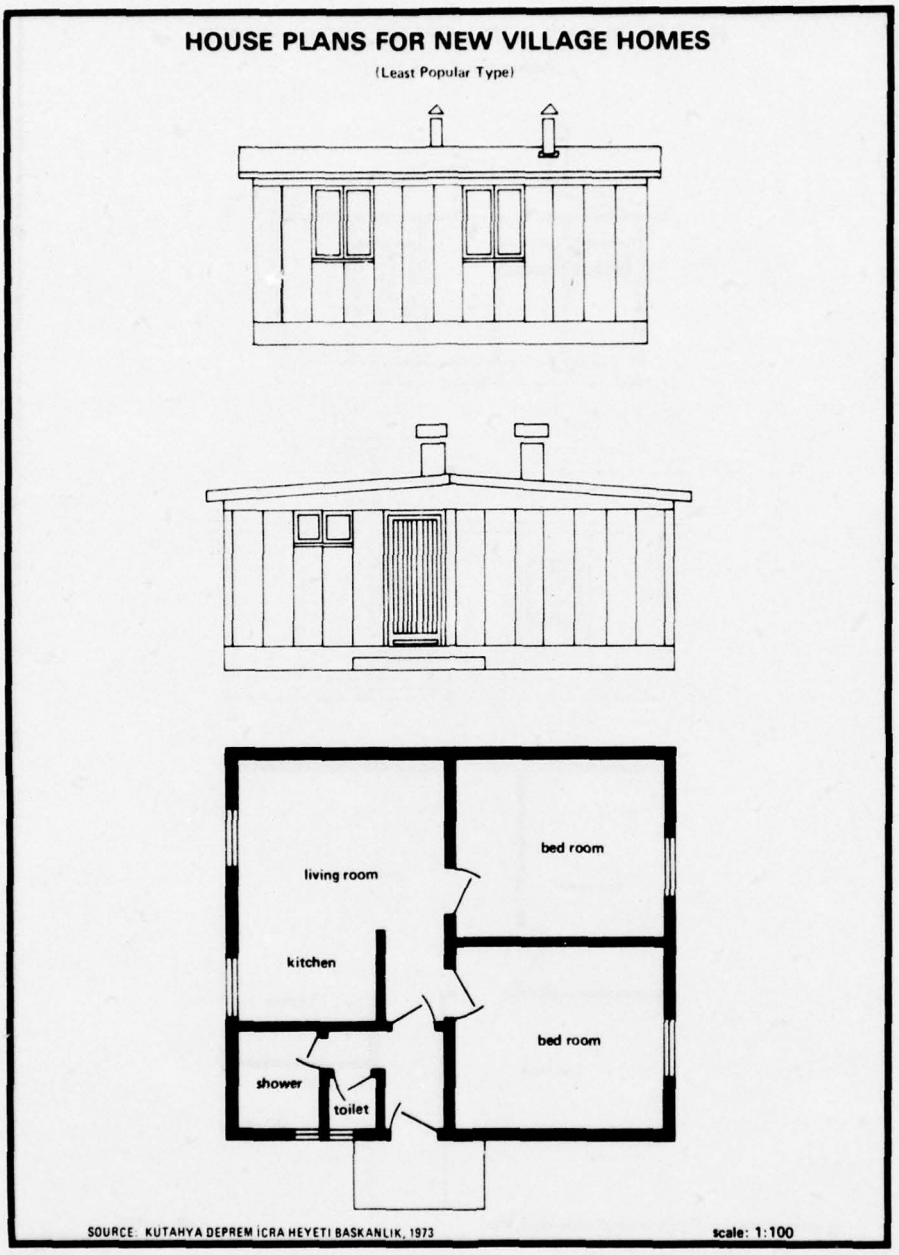

HOUSE PLANS FOR NEW VILLAGE HOMES
(Least Popular Type)
living room
bed room
kitchen
bed room
shower
toilet
SOURCE: KUTAHYA DEPREM İCRA HEYETI BASKANLIK, 1973
scale: 1:100

Figure A20

Figure A21. One of the earthquake resistant houses built in Lice by the Ministry of Reconstruction and Resettlement several years ago after a rockslide. Note the dislocated tiles on the roof and the fallen plaster.

Figure A22. Another of the 150 houses built after the rockslide several years ago.

Figure A23. The terracing effect is clear in this picture. There were five levels of unreinforced and poorly connected adobe material in this building.

Figure A24. An example of the roof and wall failures in Lice.

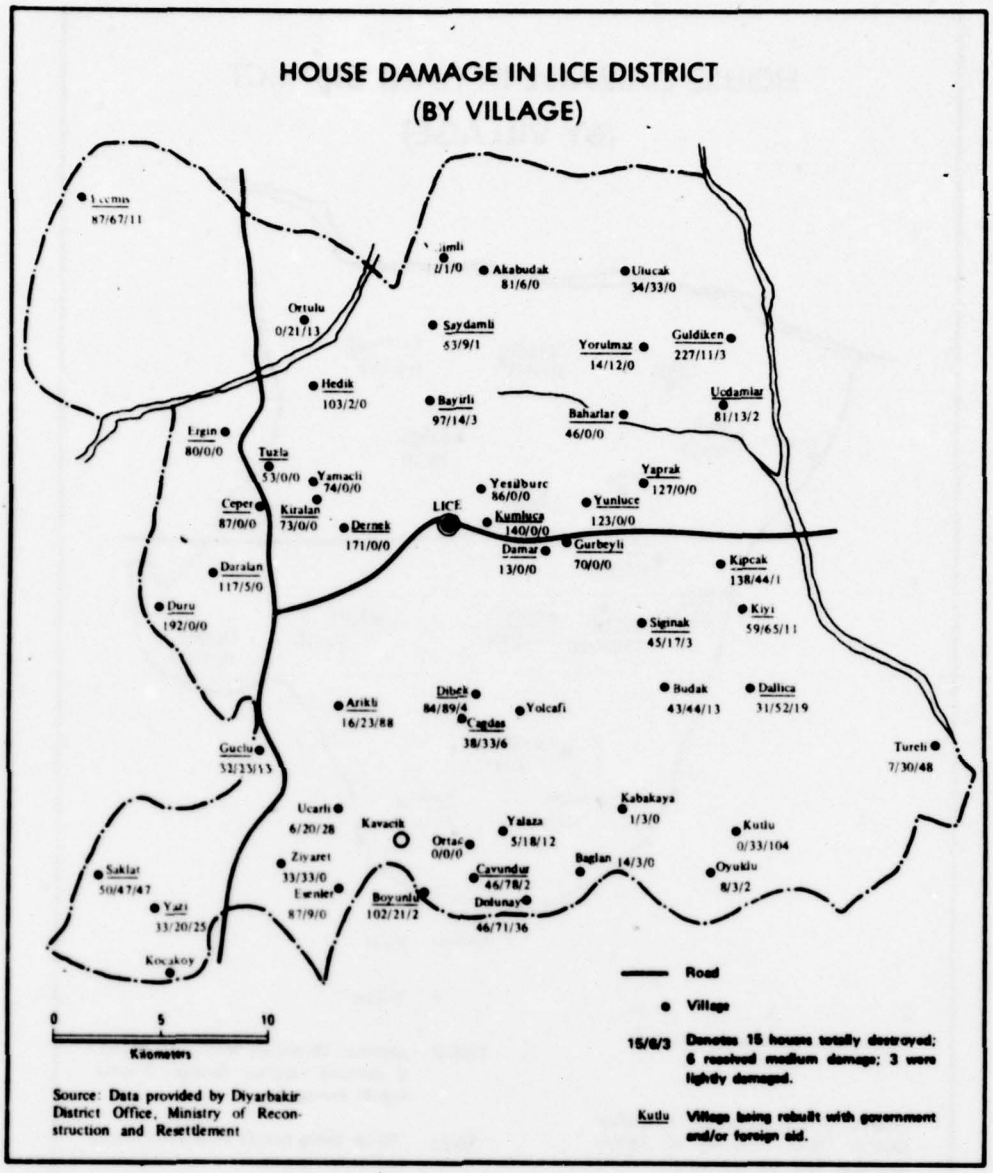

HOUSE DAMAGE IN LICE DISTRICT
(BY VILLAGE)
Ucmis
87/67/11
Akabudak
81/6/0
Ulucak
34/33/0
Ortulu
0/21/13
Saydamli
63/9/1
Yorulmaz
14/12/0
Guldiken
227/11/3
Hedik
103/2/0
Bayirli
97/14/3
Baharlar
46/0/0
Ucdamlar
81/13/2
Ergin
80/0/0
Tuzla
53/0/0
Yamacli
74/0/0
Yesilburc
86/0/0
Yaprak
127/0/0
Ceper
87/0/0
Kiralan
73/0/0
Dernek
171/0/0
LICE
Kumlusa
140/0/0
Yunluce
123/0/0
Damar
13/0/0
Gurbeyli
70/0/0
Kipcak
138/44/1
Daralan
117/5/0
Duru
192/0/0
Kiyi
59/65/11
Siginak
45/17/3
Budak
43/44/13
Dallica
31/52/19
Arikli
16/23/88
Dibek
84/89/4
Yolcati
Cegdas
38/33/6
Guclu
32/33/33
Tureli
7/30/48
Ucarli
6/20/28
Kavacik
Kabakaya
1/3/0
Yalaza
5/18/12
Kutlu
0/33/104
Ortac
0/0/0
Baglan
14/3/0
Saklar
50/47/47
Ziyaret
33/33/0
Cavundur
46/78/2
Oyuklu
8/3/2
Esenler
87/9/0
Boyunlu
102/21/2
Dolunay
46/71/36
Yazi
33/20/25
Kocakoy
0
5
10
Kilometers
Road
Village
15/6/3
Denotes 15 houses totally destroyed; 6 received medium damage; 3 were lightly damaged.
Kutlu
Village being rebuilt with government and/or foreign aid.
Source: Data provided by Diyarbakir District Office, Ministry of Reconstruction and Resettlement

Figure A25

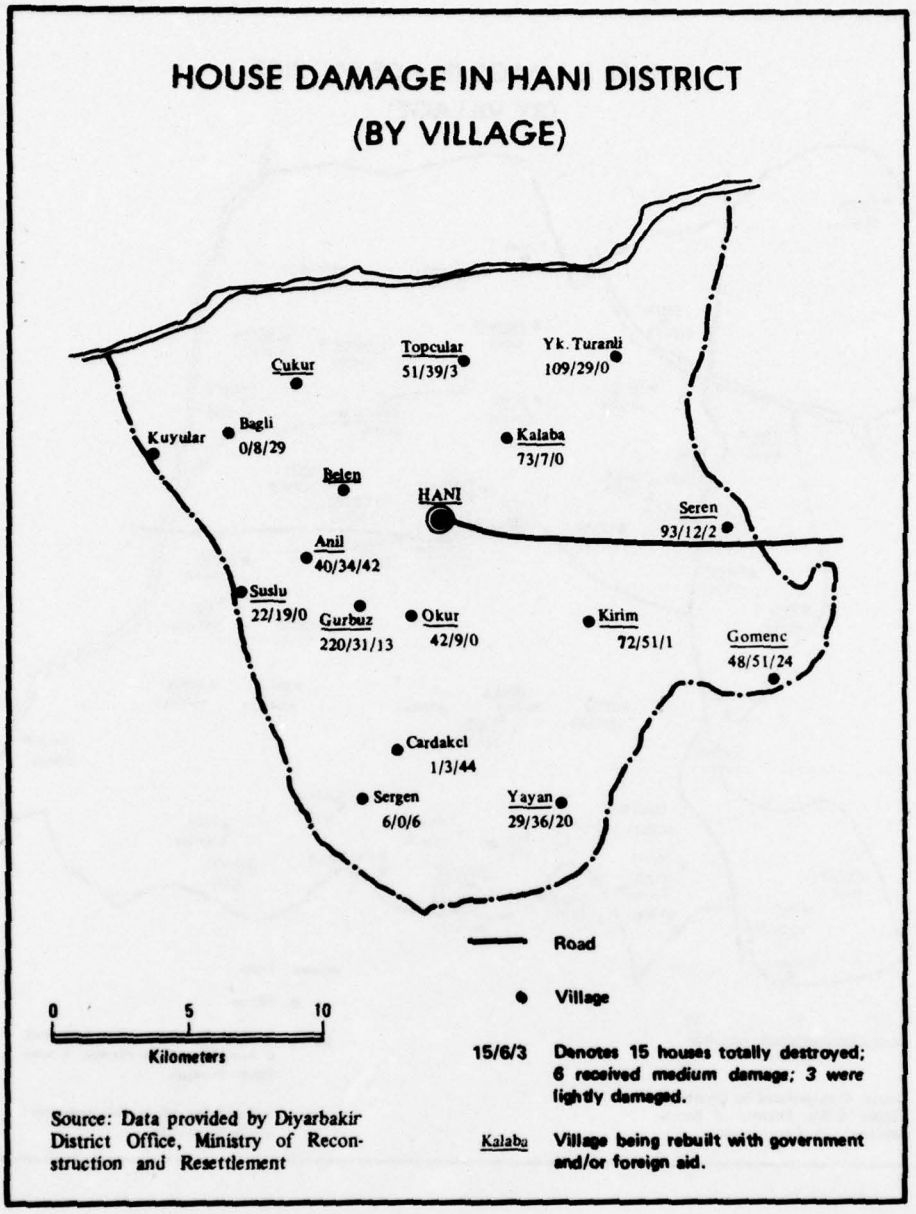

HOUSE DAMAGE IN HANI DISTRICT
(BY VILLAGE)
Cukur
Topcular
51/39/3
Yk. Turanli
109/29/0
Kuyular
Bagli
0/8/29
Kalaba
73/7/0
Belen
HANI
Seren
93/12/2
Anil
40/34/42
Suslu
22/19/0
Gurbuz
220/31/13
Okur
42/9/0
Kirim
72/51/1
Gomenc
48/51/24
Cardakcl
1/3/44
Sergen
6/0/6
Yayan
29/36/20
Road
Village
0
5
10
Kilometers
15/6/3
Denotes 15 houses totally destroyed; 6 received medium damage; 3 were lightly damaged.
Kalaba
Village being rebuilt with government and/or foreign aid.
Source: Data provided by Diyarbakir District Office, Ministry of Reconstruction and Resettlement

Figure A26

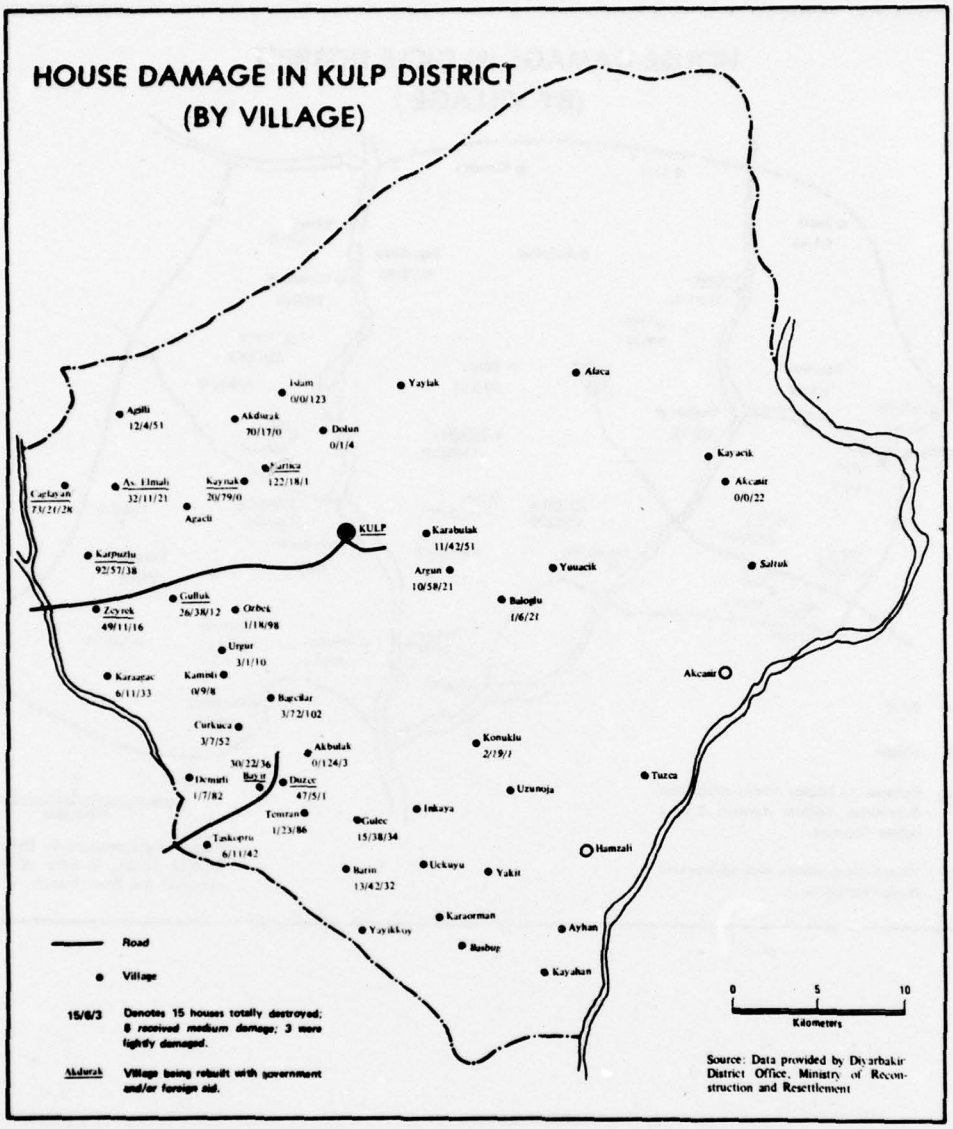

HOUSE DAMAGE IN KULP DISTRICT
(BY VILLAGE)
Islam
0/0/123
Yaylak
Alaca
Agilli
12/4/51
Akdurak
70/17/0
Dolun
0/1/4
Kayacik
Akcasir
0/0/22
Kartlica
122/18/1
Caglayan
73/21/28
Ay. Elmali
32/11/21
Kayinak
20/79/0
Aracli
KULP
Karabulak
11/42/51
Karpuzlu
92/57/38
Argun
10/58/21
Yavacik
Saltuk
Baloglu
1/6/21
Zeytek
49/11/16
Gulluk
26/38/12
Orbek
1/18/98
Urgur
3/1/10
Karaagac
6/11/33
Kamisli
0/9/8
Akcasir
Bagcilar
3/72/102
Curkuca
3/7/52
Konuklu
2/19/1
Akbulak
0/124/3
30/22/36
Bayir
Demirli
1/7/82
Duzce
47/5/1
Tuzca
Uzunoja
Inkaya
Temran
1/23/86
Gulec
15/38/34
Taskopru
6/11/42
Hamzali
Uckuyu
Yakit
Ilarm
13/42/32
Karaorman
Yayikkoy
Ayhan
Basbug
Kayahan
Road
Village
15/6/3
Denotes 15 houses totally destroyed; 8 received medium damage; 3 more lightly damaged.
Akdurak
Village being rebuilt with government and/or foreign aid.
0
5
10
Kilometers
Source: Data provided by Diyarbakir District Office, Ministry of Reconstruction and Resettlement

Figure A27

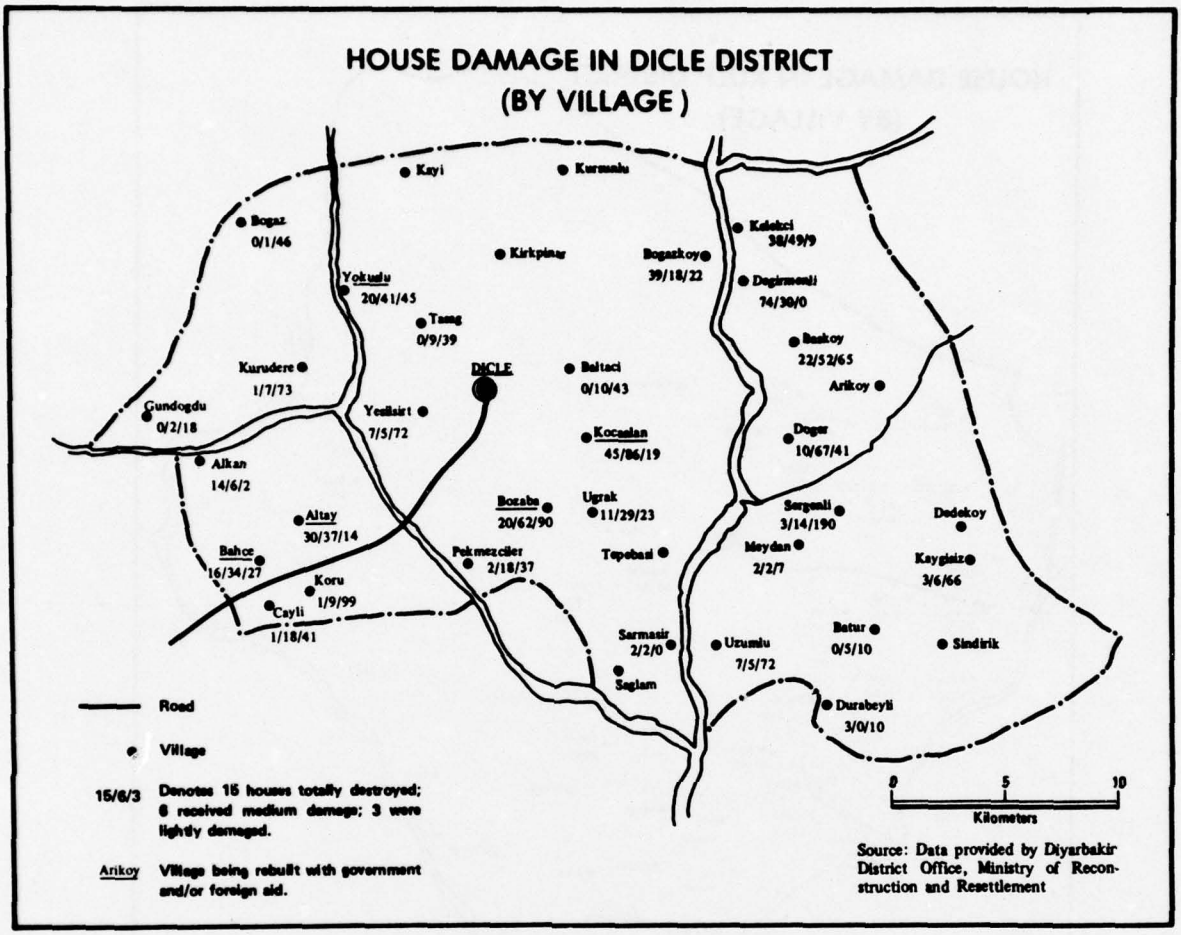

HOUSE DAMAGE IN DICLE DISTRICT
(BY VILLAGE)
Kayi
Kurmalu
Bogaz
0/1/46
Kirkpinar
Bogazkoy
39/18/22
Kalekci
38/49/9
Degirmenli
74/30/0
Yokuslu
20/41/45
Tasag
0/9/39
Baskoy
22/52/65
Arikoy
Kurudere
1/7/73
DICLE
Baltaci
0/10/43
Gundogdu
0/2/18
Yenisirt
7/5/72
Kocaslan
45/86/19
Doger
10/67/41
Alkan
14/6/2
Bozabe
20/62/90
Ugrak
11/29/23
Sergenli
3/14/190
Dedekoy
Altay
30/37/14
Meydan
2/2/7
Bahce
16/34/27
Pekmezciler
2/18/37
Tepebasi
Kaygisiz
3/6/66
Koru
1/9/99
Cayli
1/18/41
Sarmasir
2/2/0
Uzumlu
7/5/72
Batur
0/5/10
Sindirik
Saglam
Durabeyli
3/0/10
Road
Village
15/6/3
Denotes 15 houses totally destroyed; 6 received medium damage; 3 were lightly damaged.
Arikoy
Village being rebuilt with government and/or foreign aid.
0
5
10
Kilometers
Source: Data provided by Diyarbakir District Office, Ministry of Reconstruction and Resettlement

Figure A28

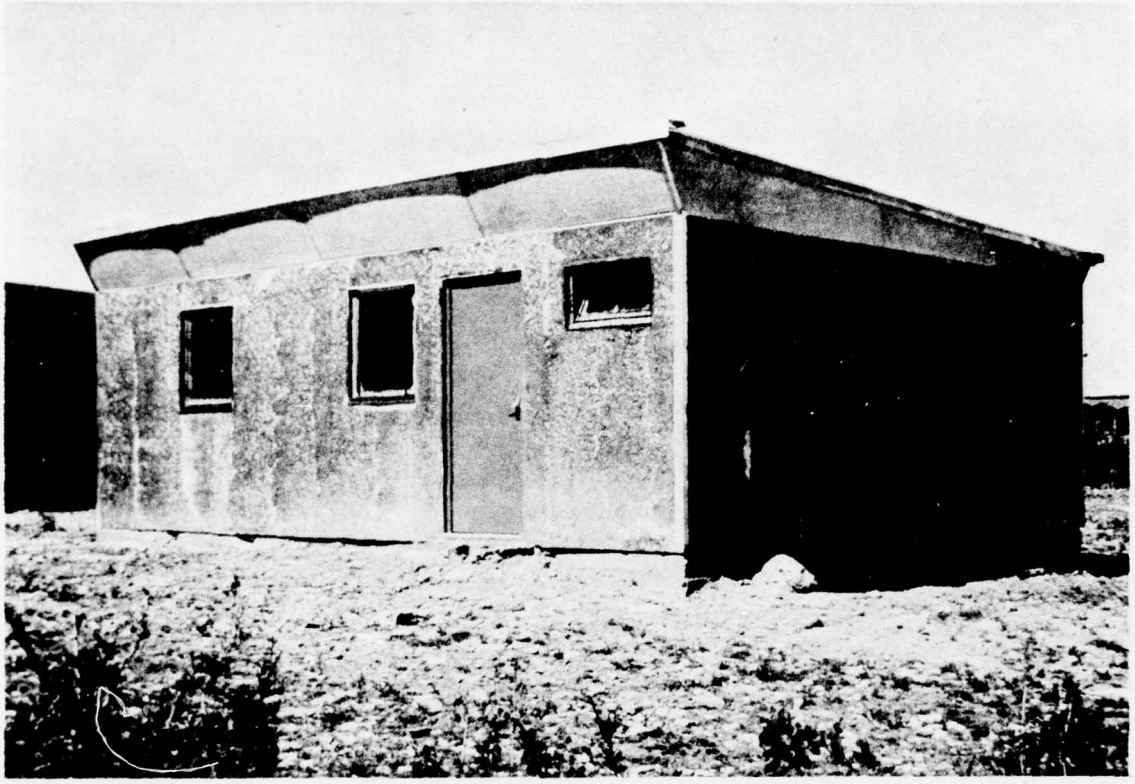


Figure A29. Güçlü village, one of the 704 French style houses already completed.

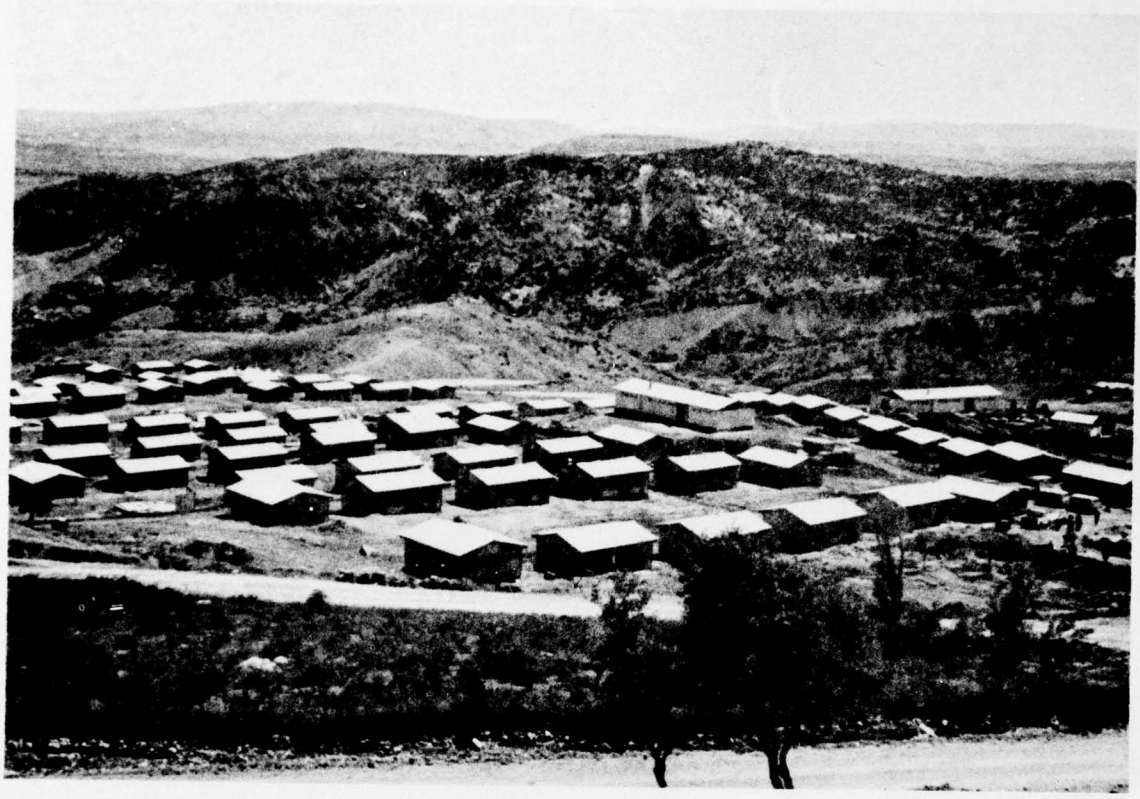


Figure A30. German style construction near Kulp.

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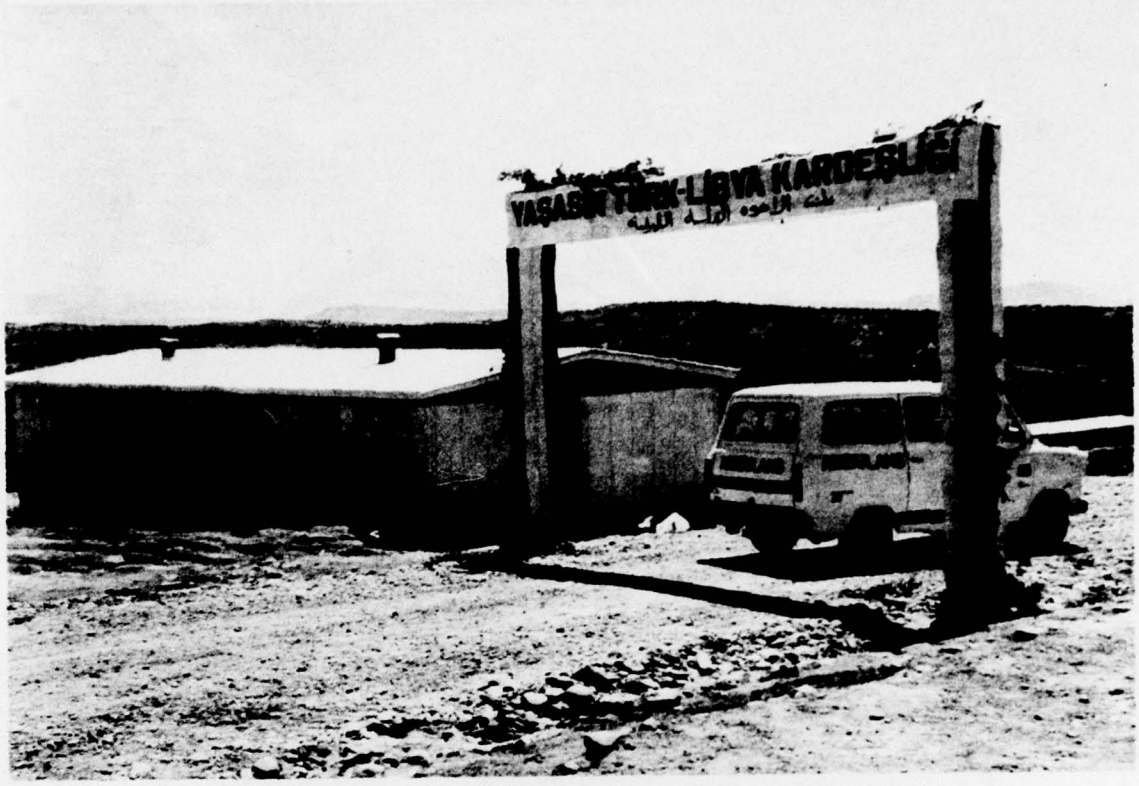

Figure A31. A duplex in the Libyan supported village of Yaprak.

Figure A32. Yugoslav style houses near Hani.
Houses were wired for electricity.

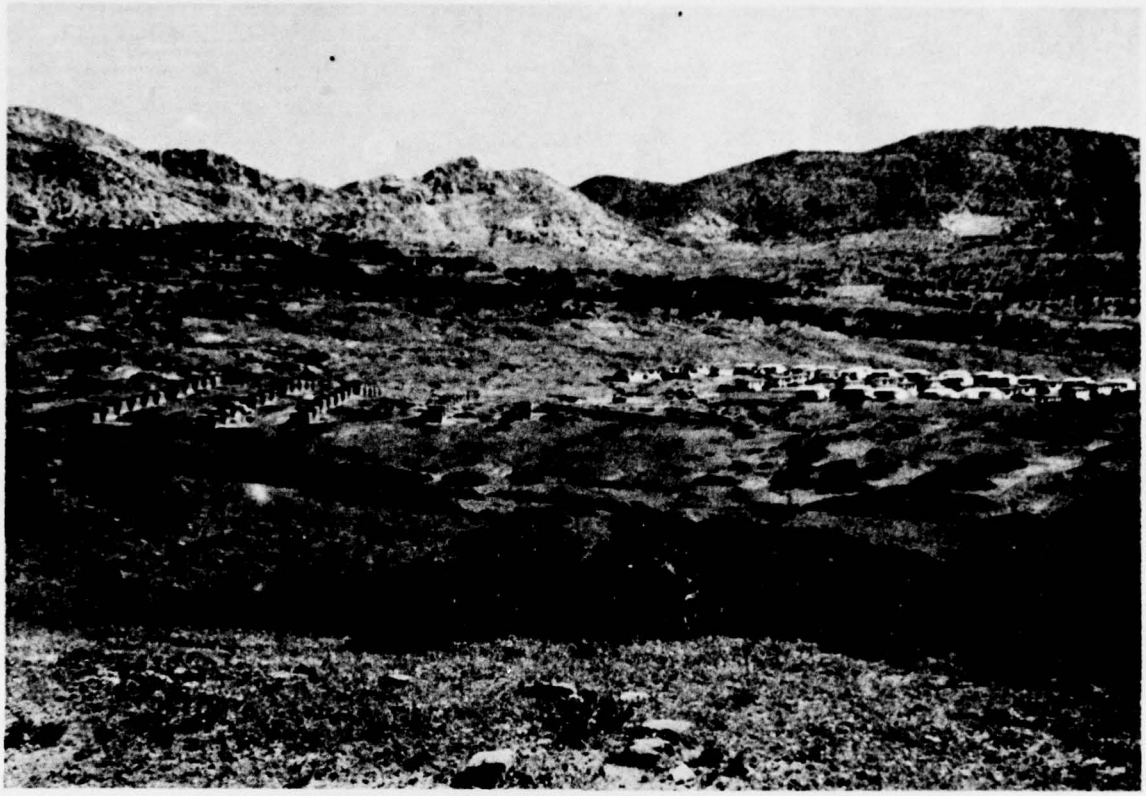

Figure A33. The Swiss supported village of Yünlüce. The 50 houses on the left were started by the Ministry of Reconstruction and Resettlement prior to the earthquake. Some were damaged by the earthquake. The white area on the mountain is another of the numerous rockslides.

Figure A34. Yünluce. Notice the animal corrals constructed around the two center houses. A Swiss flag is displayed beside the Turkish flag.

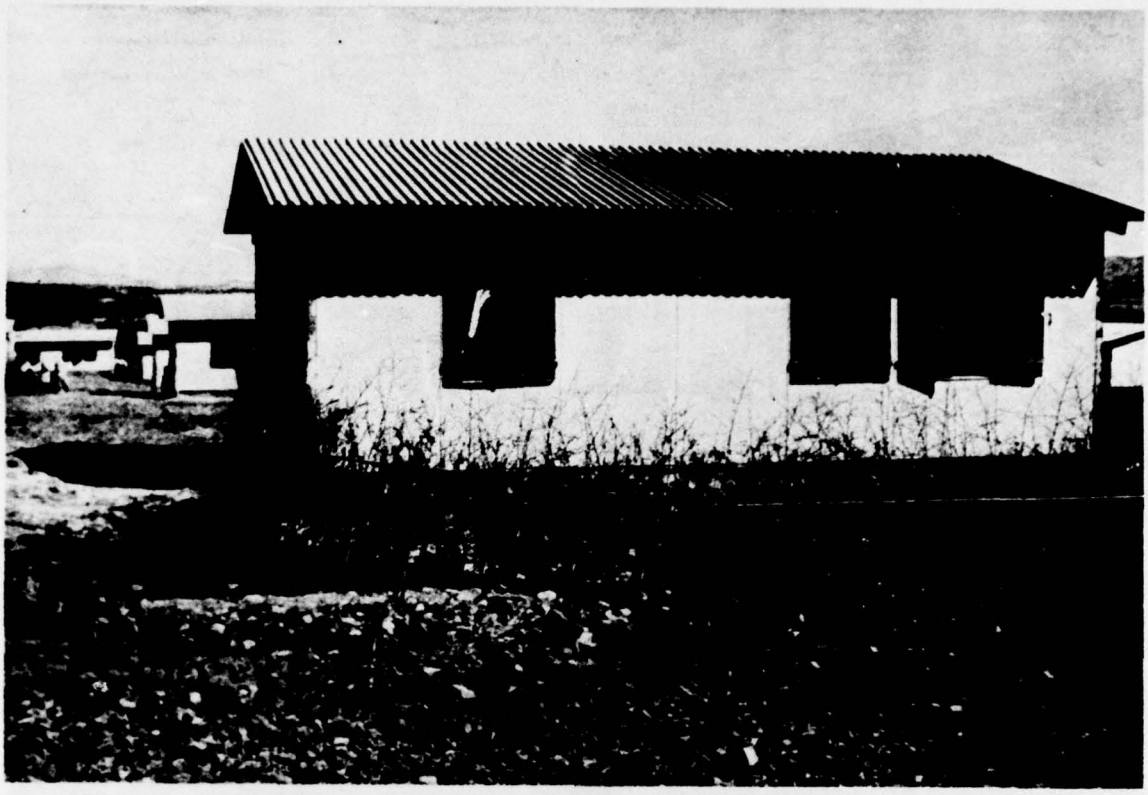

Figure A35. A close up of a Swiss style house in Yünlüce. Note the wooden shutters and animal corral.

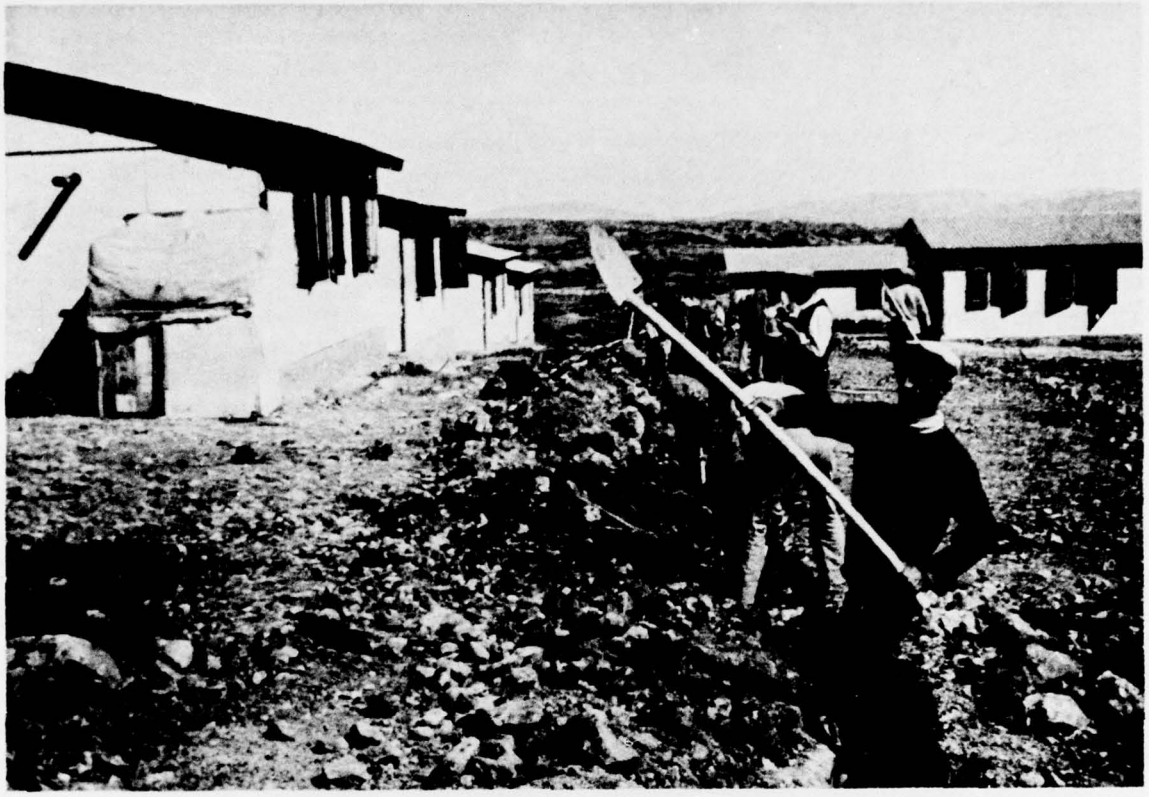

Figure A36. Yűnlüce villagers were employed by the Swiss officials to assist in constructing their new village. The villagers are digging a ditch for the water pipe line.

Figure A37. German style construction near Kulp. As with most new houses, there are no operational facilities for toilet or kitchen drainage.

Figure A38. Yaprak village.

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