6-3 Infrastructure and Lifelines

6-3-1 Bridges

(1) Method

A methodology proposed by Kubo / Katayama (hereinafter referred to as "Katayama's method") is selected in this study. An outline of this evaluation system is shown in Figure 6-8.

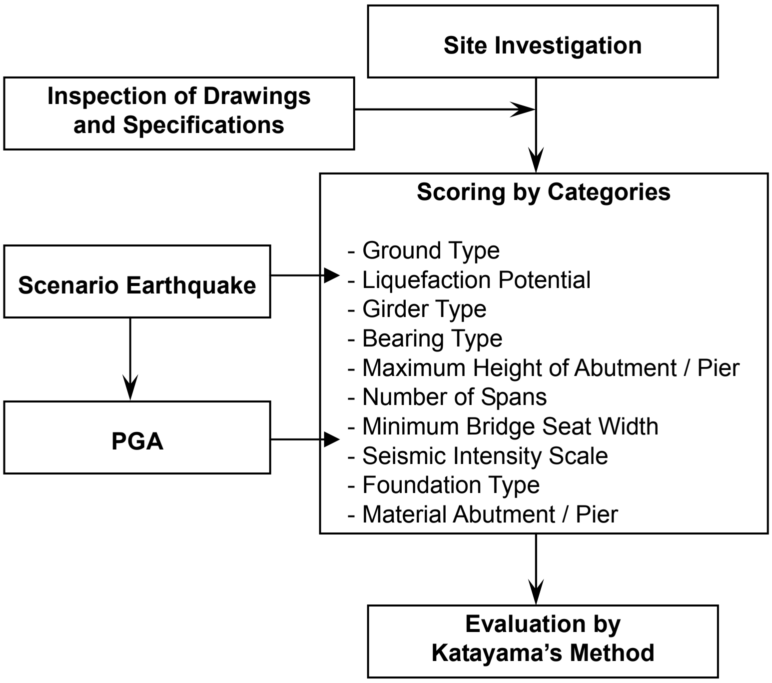

Figure 6-8 Flowchart of Stability Analysis of Bridges

In this study, the JST and the counterpart verified this method using relating records of the Boumerdes Earthquake. As a result, the definition of the class of damage grade and the threshold value were modified as shown in Table 6-5.

Table 6-5 Definition of Damage Grade of Bridges

Class of damage grade		Original threshold value of predictor	Modified threshold value of predictor
A	- High probability of girders falling - Generates huge deformation - Impossible to use for long term and requires reconstruction	30 and more	30 and more
B	- Moderate probability of girders falling - Generates deformation - Impossible to use temporarily and requires repairing / rehabilitation	26 to less than 30	22 to less than 30
C	- Low probability of girder falling - Generates small deformation - Possible to basically use after inspection	less than 26	less than 22

(2) Verification of Method

Table 6-6 shows summary of the verification for Katayama's method.

Table 6-6 Summary of Verification of Katayama's Method

Bridge	Case by MSK Scale	Total Score	Class of Damage Grade		Verification
			Katayama's Method*	Actual Damage	
SEBAO	1	25.7	B	B	Falling of the girders did not occur, but displacement was generated. Probability of falling girders is evaluated by the actual damage as class "B" that is very close to class "A". Hence, the result of the method shows a good match for the actual damage.
	2	29.4	B		
	3	36.7	A		
EL HARRACH	1	19.3	C	B	Falling of the girders did not occur, and slight displacement was generated. Probability of falling girders is evaluated by the actual damage as class "B" that is very close to class "C". Hence, the result of the method shows a good match for the actual damage.
	2	22.1	B		
	3	27.6	B		

*Threshold value for evaluation of the class applies the modified value.

As the above table shows, the results of Katayama's method with modified threshold values and the actual damage to each bridge were well matched. This indicates that Katayama's method is suitable for the bridge damage estimation.

(3) Result

Table 6-7 shows a summary of the damage estimation. Figure 6-9 to Figure 6-10 shows the location map of probability of bridges with falling girders for Khair al Din and Zemmouri, respectively.

Table 6-7 Summary of Bridge Damage Estimation

Class of Damage Grade	Number of Bridges [Ratio (%)]	
	Scenario Earthquake	
	Khair al l Din	Zemmouri
A: High Probability	3 [2.0 %]	4 [2.7 %]
B: Moderate Probability	19 [12.9 %]	7 [4.7 %]
C: Low Probability	126 [85.1 %]	137 [92.6 %]
Total	148	148

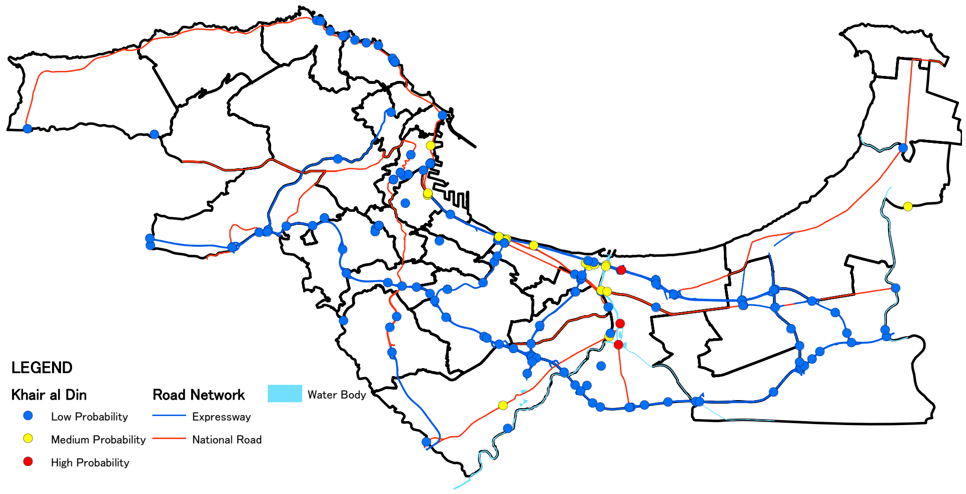

Figure 6-9 Location Map of Probability of Bridges with Falling girders: Khair al Din

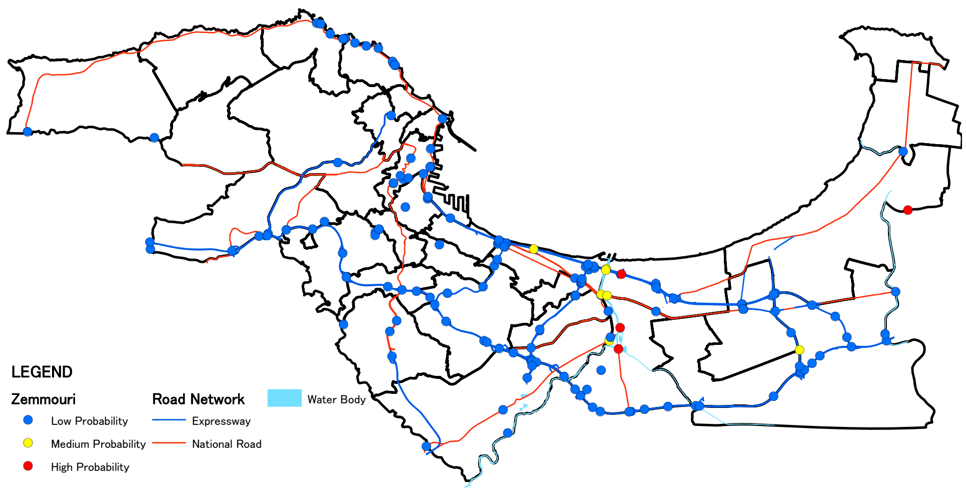

Figure 6-10 Location Map of Probability of Bridges with Falling girders: Zemmouri

(4) Discussion

For class "A" and "B" bridges located in high seismicity and / or liquefaction prone areas, lateral movement of the piers / abutments due to liquefaction increases the probability of girders falling off the bridges. Hence, the bridges evaluated as class "A" and "B" should be investigated to judge the necessity of counter measures in case of liquefaction.

6-3-2 Ports

(1) Damage Function

In seismic microzonation studies in Japan, a relationship between damage grade and ground motion / liquefaction potential was compiled as shown in Table 6-8, this being based on the past earthquakes including the Kobe Earthquake in 1995.

Table 6-8 Damage to Ports due to Past Earthquakes

	Ground Acceleration (gal)				
	0 to 150	150 to 200	200 to 300	300 to 450	more than 450
Liquefying soil	0	1	2	3	3
Non liquefying soil	0	0	1	2	3

Damage grade 0 : No damage
Damage grade 1 : Slight damage, there are cracks and deformation to sub-structures
Damage grade 2 : Moderate damage, there is deformation to main-structures
Damage grade 3 : Heavy damage, there is heavy deformation to main-structures and function is lost

(2) Result and Discussion

Figure 6-11 shows the result of the port damage estimation.

In a case similar to Khair al Din, the north part of the port will suffer moderate damage and other parts may cease to function. In a case similar to Zemmouri, the north part of the port will continue to function, however, other parts, especially the berth area, will suffer heavy damage and may also cease to function.

Scenario Earthquake: Khair al Din

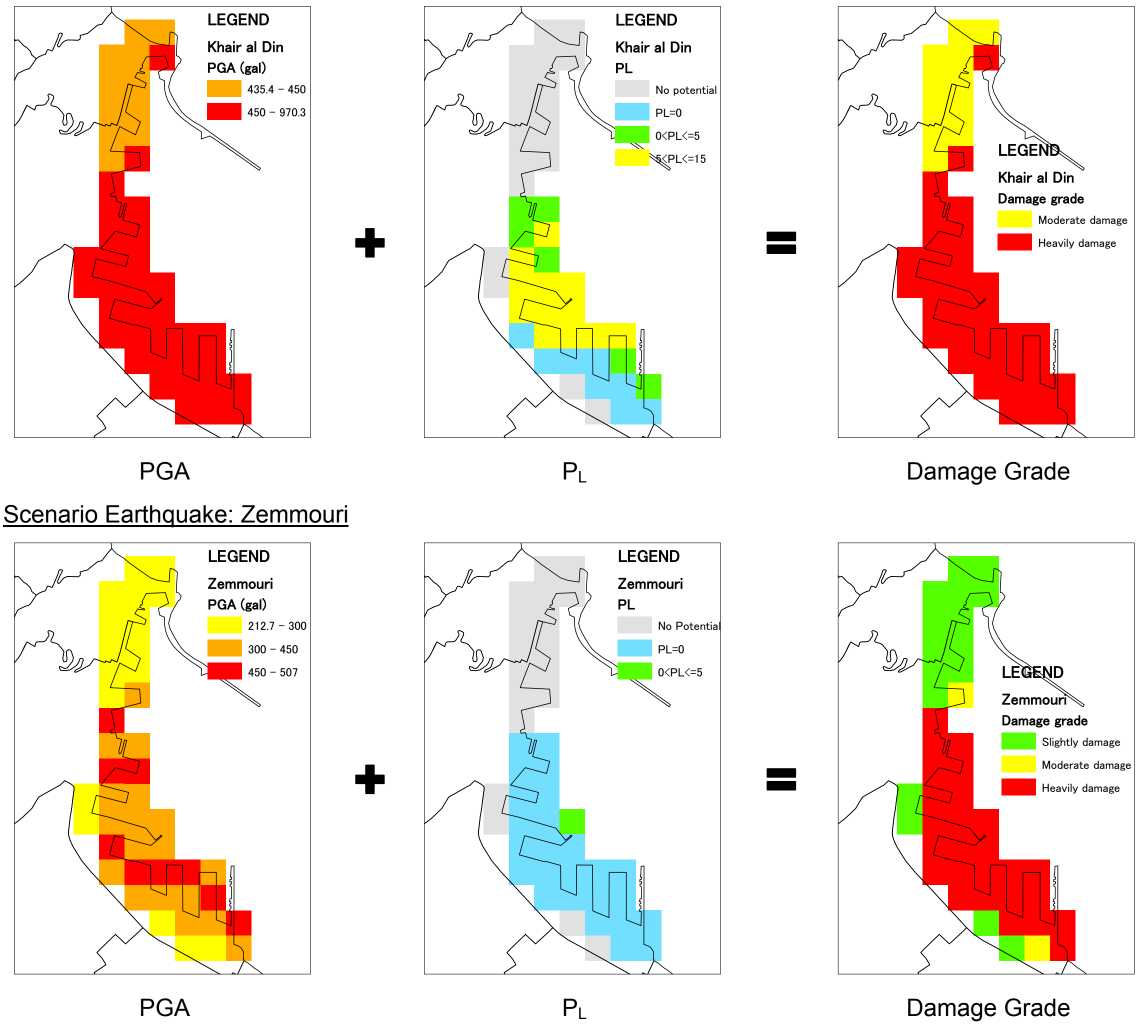

Figure 6-11 Result of Port Damage Estimation

6-3-3 Airports

(1) Damage Function

Airport damage for the scenario earthquake is estimated from the relationship between damage experienced and earthquake motion (PGA). Here, the airport damage function is defined as in Table 6-9.

Table 6-9 Relationship between Damage Grade and Peak Ground Acceleration

PGA (gal)	0 to 200	200 to 300	more than 300
Damage Grade	0	1	2

Damage Grade 0 : No Damage
Damage Grade 1 : Minor Damage, Airport will not be closed more than 1 days
Damage Grade 2 : Major Damage, Airport will be closed for several days

(2) Result and Discussion

Figure 6-12 shows the result of the airport damage estimation.

Damage is estimated to be the same grade (damage grade 2, the airport will be closed for a few days), however, it is expected that the Zemmouri case will affect the airport more adversely than the Khair al Din case due to the difference of the PGA.

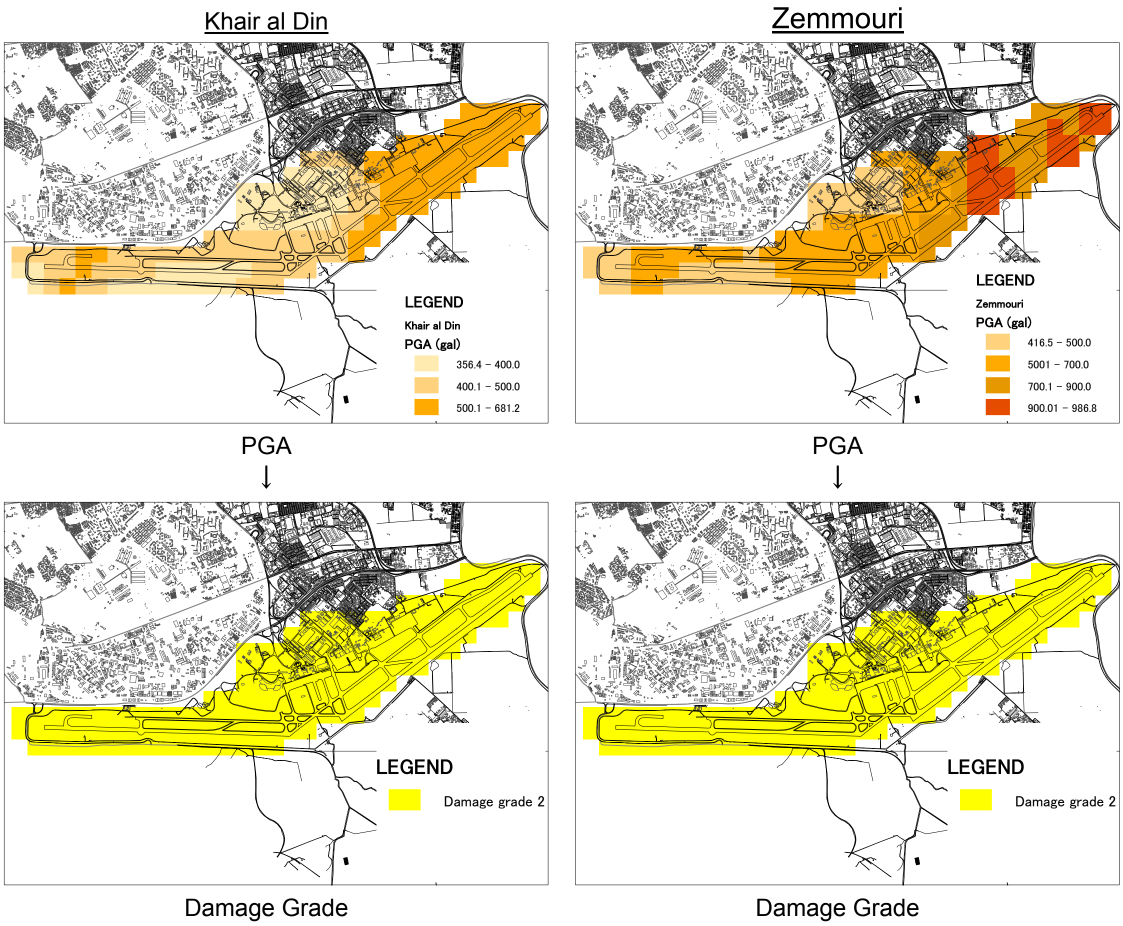

Figure 6-12 Result of Airport Damage Estimation

6-3-4 Water Supply

(1) Water Supply Pipelines

1) Damage Function

In this study, the applied damage functions were examined with the counterpart, and then mean values of the coefficients out of the many introduced values were applied as follows:

$R_{fm} = R_f * C_g * C_p * C_d$

where

R_{fm} : Damage ratio (points/km)
R_f : Standard damage ratio (points/km)
$R_f = 1.7 * A^{6.1} * 10^{-16}$ ---------- (maximum $R_f = 2.0$)
A : Peak ground acceleration (gal)
C_g : Modification coefficient for ground type with liquefaction potential
C_p : Modification coefficient for pipeline material
C_d : Modification coefficient for pipeline diameter

2) Result and Discussion

As far as the locality feature of the result is concerned, the commune that is estimated to generate the most damage points, and the highest damage ratio (points/km) will be BORDJ EL KIFFAN for both cases (Khair al Din and Zemmouri), and HUSSEIN DEY for the Khair al Din case and BORDJ EL BAHRI for Zemmouri case, respectively (see Table 6-10).

Table 6-10 Results of Damage Estimation of Water Supply Pipelines

Commune Name	Tota; Length (km)	Khair al Din		Zemmouri	
		Damage Points	Damage Ratio (points/km)	Damage Points	Damage Ratio (points/km)
ALGER CENTRE	83.6	92	1.10	2	0.02
SIDI M'HAMED	61.2	91	1.49	0	0.00
EL MADANIA	55.1	50	0.91	1	0.02
HAMMA EL ANNASSER	50.4	82	1.63	3	0.06
BAB EL OUED	37.9	53	1.40	0	0.00
BOLOGHINE IBNOU ZIRI	45.8	71	1.55	0	0.00
CASBAH	36.7	42	1.14	0	0.00
OUED KORICHE	36.7	50	1.36	0	0.00
BIR MOURAD RAIS	69.0	65	0.94	0	0.00
EL BIAR	81.7	202	2.47	13	0.16
BOUZAREAH	126	77	0.61	0	0.00
BIRKHADEM	103.3	84	0.81	2	0.02
EL HARRACH	70.8	136	1.92	120	1.69
OUED SMAR	31.4	57	1.82	59	1.88
BOUROUBA	51.7	113	2.19	76	1.47
HUSSEIN DEY	54.5	241	4.42	91	1.67
KOUBA	147.5	347	2.35	68	0.46
BACHDJARAH	58.1	137	2.36	50	0.86
DAR EL BEIDA	65.1	184	2.83	185	2.84
BEB EZZOUAR	55.5	151	2.72	154	2.77
BEN AKNOUN	41.0	31	0.76	0	0.00
DELY BRAHIM	92.0	64	0.70	0	0.00
EL HAMMAMET	29.1	16	0.55	0	0.00
RAIS HAMIDOU	38.8	48	1.24	1	0.03
DJASR KASANTINA	129.1	191	1.48	24	0.19
EL MOURADIA	55.3	66	1.19	3	0.05
HYDRA	77.8	99	1.27	0	0.00
MOUHAMMADIA	37.8	94	2.49	89	2.35
BORDJ EL KIFFAN	108.5	378	3.48	374	3.45
EL MAGHARIA	23.3	84	3.61	35	1.50
BENI MESSOUS	36.0	29	0.81	0	0.00
BORDJ EL BAHRI	54.7	206	3.77	206	3.77
EL MARSA	24.5	80	3.27	80	3.27
AIN BENIAN	78.3	254	3.24	0	0.00
Total	2,148.2	3,965	1.85	1,636	0.76

Figure 6-13 to Figure 6-14 shows the result of the damage estimation for the water supply pipeline by 250 m grid sectors. The damage points will concentrate in the central part of the study area and / or along the coastline for the Khair al Din case and in the eastern part of the study area for the Zemmouri case.

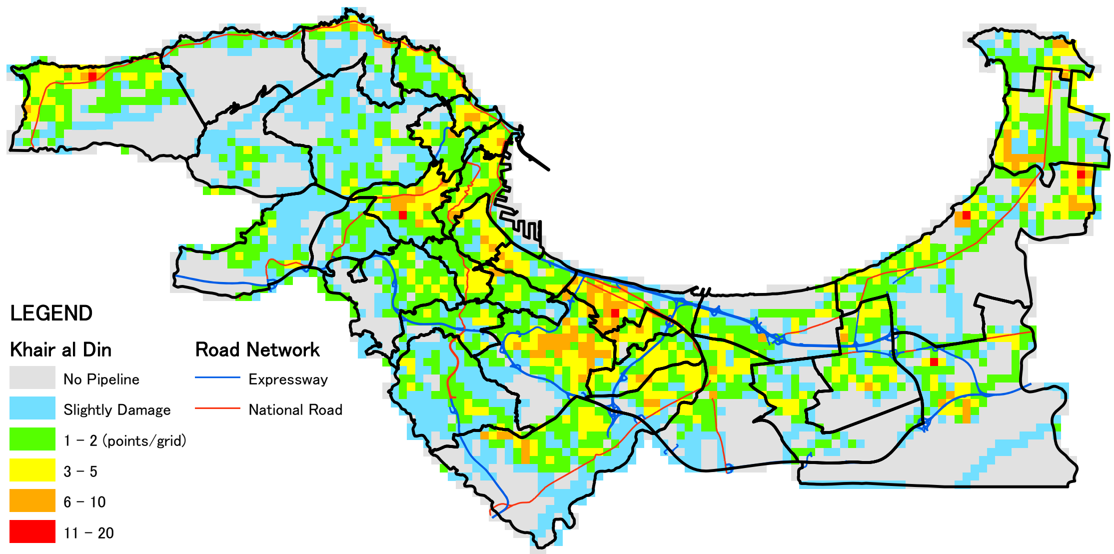

Figure 6-13 Damage Points of Water Supply Pipeline: Khair al Din

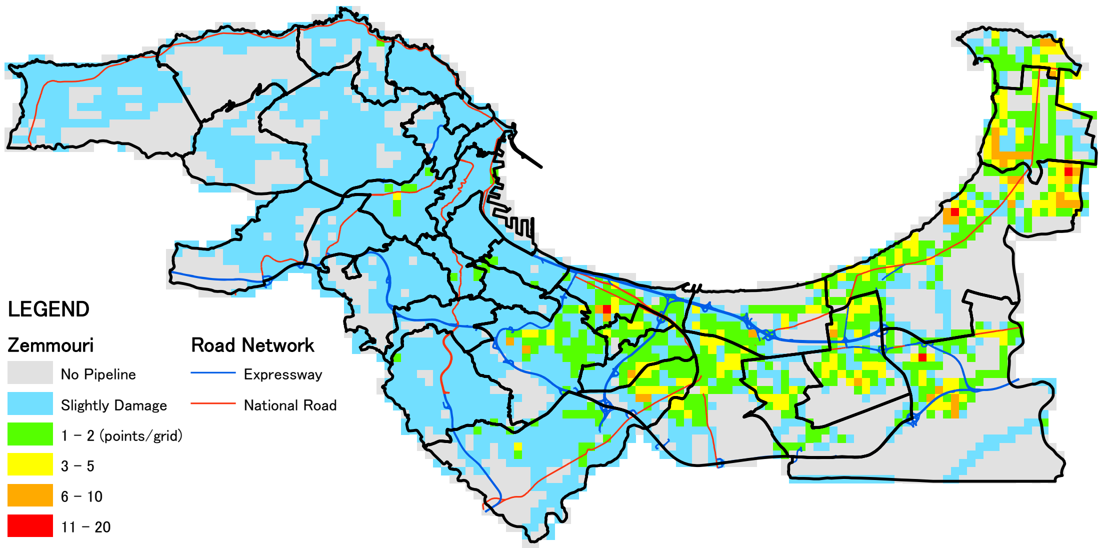

Figure 6-14 Damage Points of Water Supply Pipeline: Zemmouri

(2) Elevated Water Supply Tanks

Empirical approaches for the estimation of damage to the elevated water supply tanks are problematic because few reports exist regarding past damage. Hence, the vulnerability of the tanks for the scenario earthquake was evaluated qualitatively by overlaying the tank locations on a geo-hazard map that consists of the peak ground acceleration map, the liquefaction potential map and the slope failure risk map.

At the tanks located in high acceleration or high slope failure risk zones should be given an individual seismic assessment (ground and structure condition, etc) and the actual slope condition should be determined for its surroundings (positional relation between the tank and slope, slope stability, etc). Then the necessity of retrofitting work for aseismic should be examined.

6-3-5 Sewerage Pipelines

Vulnerability of the sewerage pipeline for the scenario earthquake was evaluated qualitatively by overlaying the pipeline network on the geo-hazard map.

The pipelines located in the "high risk" and "relatively high risk" areas have the highest priority to be assessed for seismic vulnerability if an aseismic assessment for the sewerage pipeline is undertaken.

6-3-6 Electric Power Supply Cable

The high voltage cables (220,000V or 60,000V), there have been only a few records of damage due to past earthquakes. Hence, vulnerability of the high voltage cables for the scenario earthquake was evaluated qualitatively by overlaying the cable locations on the geo-hazard maps.

The medium voltage (30,000V for rural areas or 10,000V for urbanized areas) cables, will suffer damage due to the scenario earthquake. Some damage estimation methods for the cables are recommended in Japan.

The low voltage cables, damage to these cables due to the scenario earthquake is estimated as being comparable to building damage. Hence, the damage estimation of the cables is beyond the scope of this section.

(1) Medium Voltage Cables

1) Damage Function

The concept recommends 2 damage function curves in which one is for the aerial cables and the other is for underground cables. In this study, the damage functions applied were examined with the counterpart, and then we applied the following damage function curve shown in Figure 6-15.

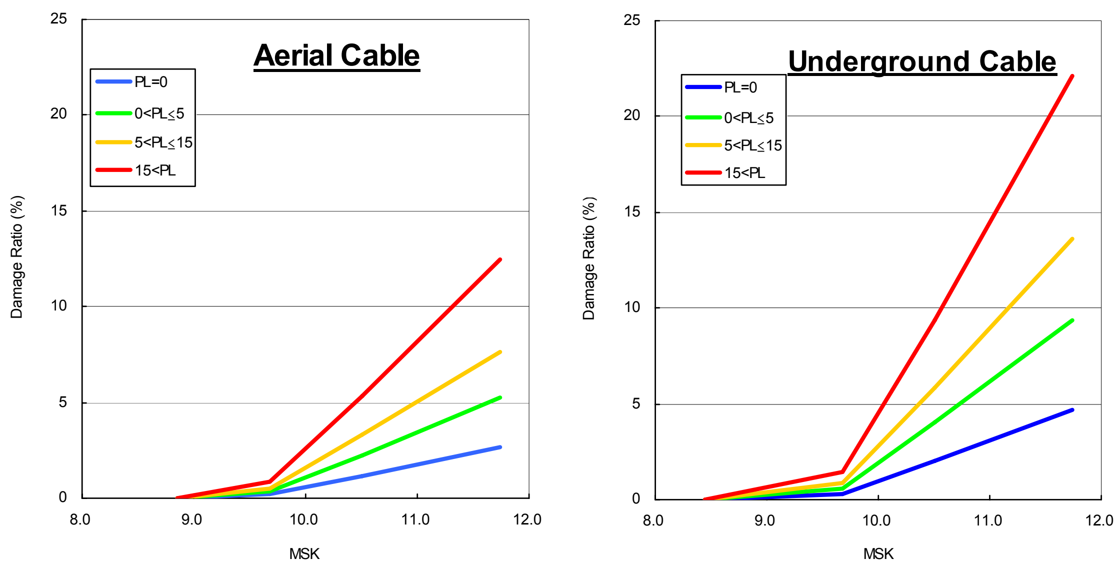

Figure 6-15 Damage Function Curve for Medium Voltage Cables

2) Results and Discussion

The commune that is projected to suffer the most damage is ALGER CENTER for the Khair al Din case and BORDJ EL KIFFAN for the Zemmouri case (see Table 6-11).

Table 6-11 Results of Damage Estimation of Medium Voltage Cables

Commune Name	Total Length			Damage Length（m）					
	(m)		(km)	Khair al Din			Zemmouri		
	Aerial Cable	Under-ground Cable	Total	Aerial Cable	Under-ground Cable	Total	Aerial Cable	Under-ground Cable	Total
ALGER CENTRE	—	59,806	59.8	—	208	208	—	15	15
SIDI M'HAMED	—	40,903	40.9	—	80	80	—	0	0
EL MADANIA	—	22,833	22.8	—	52	52	—	7	7
HAMMA EL ANNASSER	—	42,397	42.4	—	81	81	—	3	3
BAB EL OUED	—	10,843	10.8	—	16	16	—	0	0
BOLOGHINE IBNOU ZIRI	728	10,339	11.1	0	15	15	0	0	0
CASBAH	—	12,956	13.0	—	19	19	—	0	0
OUED KORICHE	—	14,017	14.0	—	27	27	—	1	1
BIR MOURAD RAIS	—	22,798	22.8	—	35	35	—	0	0
EL BIAR	—	33,051	33.1	—	106	106	—	4	4
BOUZAREAH	5,994	39,432	45.4	2	60	62	0	0	0
BIRKHADEM	2,057	2,230	4.3	1	2	3	0	0	0
EL HARRACH	13,151	11,516	24.7	11	29	40	6	19	25
OUED SMAR	3,284	8,468	11.8	3	17	20	3	24	27
BOUROUBA	2,230	2,553	4.8	3	7	10	1	5	6
HUSSEIN DEY	—	38,585	38.6	—	93	93	—	31	31
KOUBA	1,914	68,190	70.1	1	118	119	0	18	18
BACHDJARAH	—	30,683	30.7	—	60	60	—	27	27
DAR EL BEIDA	8,652	11,509	20.2	17	32	49	30	57	87
BEB EZZOUAR	4,751	21,997	26.7	5	61	66	5	72	77
BEN AKNOUN	—	35,025	35.0	—	70	70	—	0	0
DELY BRAHIM	3,617	1,789	5.4	3	3	6	0	0	0
EL HAMMAMET	1,908	5,795	7.7	2	9	11	0	0	0
RAIS HAMIDOU	34	6,241	6.3	0	11	11	0	0	0
DJASR KASANTINA	15,646	3,578	19.2	8	6	14	1	2	3
EL MOURADIA	—	17,339	17.3	—	39	39	—	2	2
HYDRA	—	39,170	39.2	—	71	71	—	0	0
MOUHAMMADIA	520	15,526	16.0	1	40	41	0	32	32
BORDJ EL KIFFAN	21,617	4,479	26.1	70	15	85	91	17	108
EL MAGHARIA	—	12,780	12.8	—	30	30	—	12	12
BENI MESSOUS	4,298	2,949	7.2	5	4	9	0	0	0
BORDJ EL BAHRI	14,515	8,639	23.2	17	20	37	20	23	43
EL MARSA	3,295	4,976	8.3	5	10	15	6	12	18
AIN BENIAN	15,588	7,936	23.5	45	19	64	0	0	0
Total	123,797	671,326	795.2	199	1,465	1,664	163	383	546

Figure 6-16 to Figure 6-17 shows the result of the damage estimation for medium voltage cable by 250 m grid zone. The damage length will be concentrated in the central part of the study area for the Khair al Din scenario and eastern part of the study area for the Zemmouri scenario.

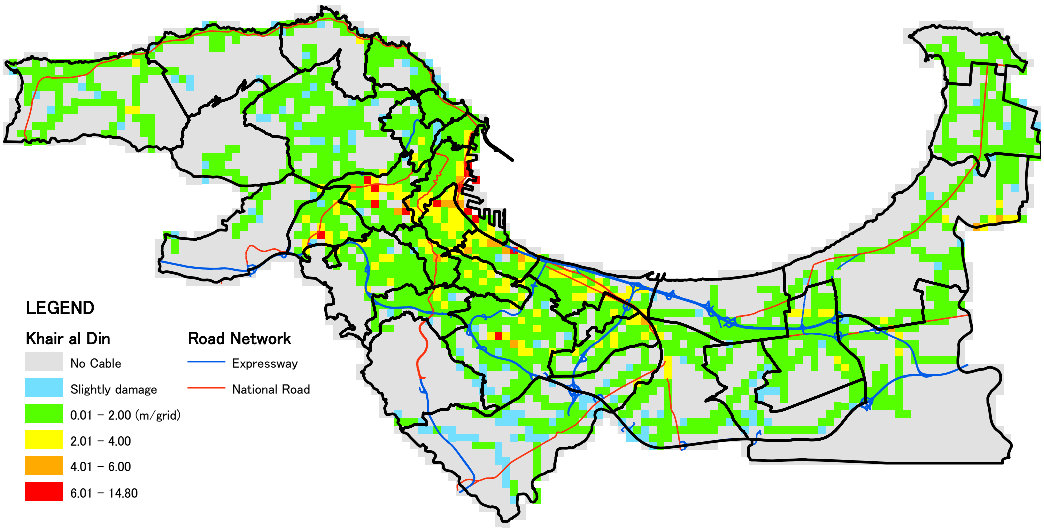

Figure 6-16 Damage Length of Medium Voltage Cable: Khair al Din

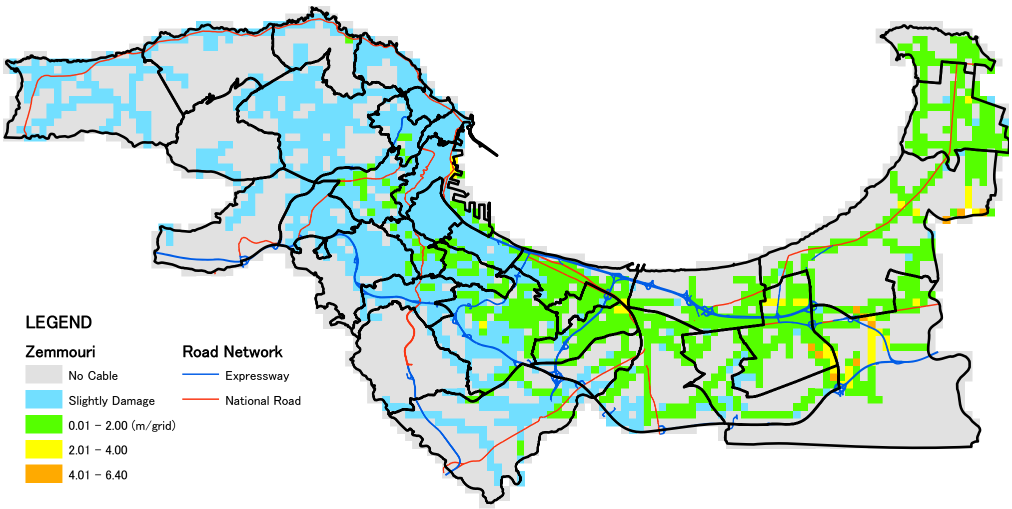

Figure 6-17 Damage Length of Medium Voltage Cable: Zemmouri

(2) High Voltage Cables

The cables / substations located in the "high risk" and "relatively high risk" areas have a high priority for seismic assessment if an aseismic assessment for the high voltage network systems is executed.

6-3-7 Gas Supply Pipelines

The high pressure gas pipelines are based on aseismic design and are buried underground. There are few damage records as a result of past earthquakes, including the Boumerdes Earthquake. Hence, vulnerability of the high pressure gas pipelines for the scenario earthquakes was evaluated qualitatively by overlaying the pipeline network on the geo-hazard map.

SONELGAZ is replacing the low pressure gas pipelines with medium pressure pipelines in the Wilaya of Algiers. Hence, in this study the low pressure gas pipelines are analysed as though they were medium pressure gas pipelines.

(1) Medium Pressure Gas Pipelines

1) Damage Function

The following damage function based on damage conditions due to past earthquakes, including the Kobe Earthquake in 1995, is used for the damage estimation. The basic concept is based on the damage ratio established by Kubo and Katayama (1975) as well as the water supply pipelines (refer to section 6-3-4).

In this study, the applied damage functions were examined with the counterpart, and then the mean values of the coefficients were applied as follows:

$R_{fm} = R_f * C_g * (C_p * C_d)$

$R_f = 1.7 * A^{6.1} * 10^{-16}$ -----------------(maximum $R_f = 2.0$)

where

R_{fm} : Damage ratio (points/km)

R_f : Standard damage ratio (points/km)

A : PGA (Peak Ground Acceleration)

C_g : Modification coefficient for ground type with liquefaction potential (P_L)

$C_p * C_d$: Modification coefficient for pipeline material and diameter

2) Results and Discussion

The copper pipelines are mainly distributed in BORDJ EL KIFFAN, BACHDJARAH, BOUROUBA and MOUHAMMADIA; hence, these areas will suffer much more damage in comparison with other communes (see Table 6-12).

Table 6-12 Results of Damage Estimation of Medium Pressure Gas Pipelines

Commune Name	Total Length (km)	Khair al Din		Zemmouri	
		Damage Points	Damage Ratio (points/km)	Damage Points	Damage Ratio (points/km)
ALGER CENTRE	12.0	0	0	0	0
SIDI M'HAMED	9.7	0	0	0	0
EL MADANIA	15.2	0	0	0	0
HAMMA EL ANNASSER	15.1	1	0.07	0	0
BAB EL OUED	11.0	0	0	0	0
BOLOGHINE IBNOU ZIRI	23.6	0	0	0	0
CASBAH	7.7	0	0	0	0
OUED KORICHE	13.9	0	0	0	0
BIR MOURAD RAIS	28.6	0	0	0	0
EL BIAR	17.7	0	0	0	0
BOUZAREAH	52.3	4	0.08	0	0
BIRKHADEM	27.9	1	0.04	0	0
EL HARRACH	34.8	0	0	0	0
OUED SMAR	30.1	0	0	0	0
BOUROUBA	17.2	15	0.87	8	0.47
HUSSEIN DEY	27.3	1	0.04	0	0
KOUBA	53.9	2	0.04	1	0.02
BACHDJARAH	22.3	13	0.58	3	0.13
DAR EL BEIDA	28.6	2	0.07	2	0.07
BEB EZZOUAR	23.4	0	0	0	0
BEN AKNOUN	19.5	4	0.21	0	0
DELY BRAHIM	18.3	0	0	0	0
EL HAMMAMET	14.3	4	0.28	0	0
RAIS HAMIDOU	15.7	0	0	0	0
DJASR KASANTINA	21.2	0	0	0	0
EL MOURADIA	13.8	1	0.07	0	0
HYDRA	29.1	0	0	0	0
MOUHAMMADIA	30.4	8	0.26	8	0.26
BORDJ EL KIFFAN	46.0	22	0.48	20	0.43
EL MAGHARIA	12.0	0	0	0	0
BENI MESSOUS	16.5	0	0	0	0
BORDJ EL BAHRI	29.9	0	0	0	0
EL MARSA	12.4	0	0	0	0
AIN BENIAN	25.4	0	0	0	0
Total	776.8	78	0.10	42	0.05

Figure 6-18 to Figure 6-19 shows the result of the damage estimation for gas supply pipelines by 250 m grid zone. The damage points will be concentrated around the administrative boundary of BACHDJARAH and BOUROUBA, and the west part of BORDJ EL KIFFAN for both the Khair al Din and Zemmouri scenarios.

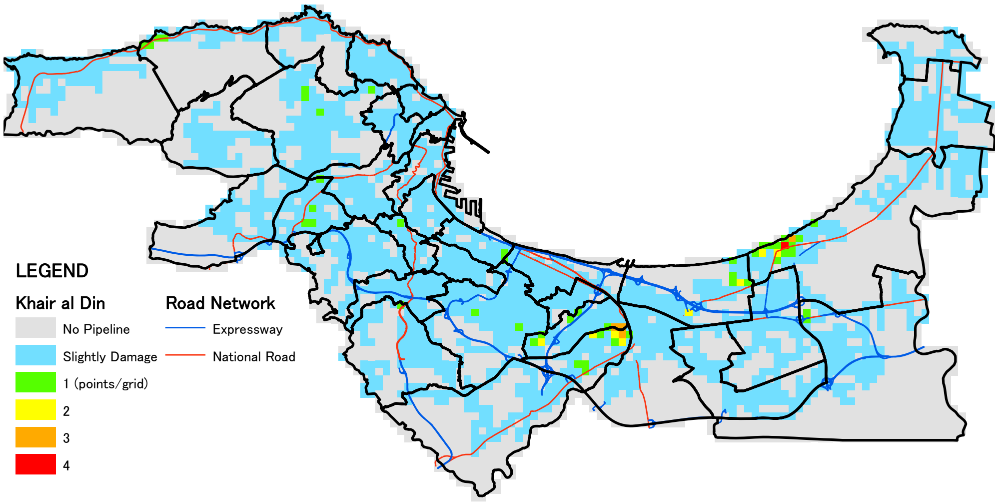

Figure 6-18 Damage Points of the Gas Supply Pipeline: Khair al Din

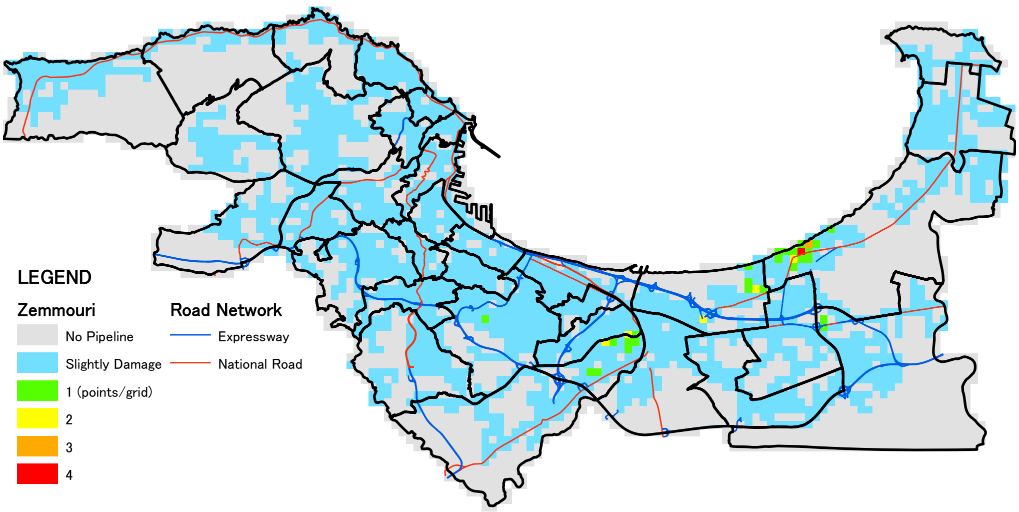

Figure 6-19 Damage Points of the Gas Supply Pipeline: Zemmouri

(2) High Pressure Gas Pipelines

The pipelines / substations located in the "high risk" and "relatively high risk" areas have a high priority for seismic assessment if an aseismic assessment for the high pressure gas pipeline network systems is executed.

6-3-8 Telecommunications

The telecommunication optic fiber cables are almost all buried underground. This is similar to the underground electric cables (medium voltage). Hence, the damage function curve of the electric cables can be used for the damage estimation of the optic fiber cables.

The damage estimation for the telecommunication facilities refers to the results of building damage estimation.

6-4 Summary of Damage Immediately after the Scenario Earthquakes

Table 6-13 summarizes the result of the damage estimation for each commune as well as the existing condition of buildings, population infrastructure and lifelines.

Table 6-13 (a) Summary of Damage in Each Commune

Category	Items			Unit	Total of 34 Communes	1601 ALGER CENTRE	1602 SIDI M'HAMED	1603 EL MADANIA	1604 HAMMA EL ANNASSER	1605 BAB EL OUED	1606 BOLOGHINE	1607 CASBAH	1608 OUED KORICHE	1609 BIR MOURAD RAIS
A. Basic Information	1. Area of Commune			ha	23,083.9	375.5	214.9	220.9	216.8	121.6	274.4	111.8	234.8	358.6
	2. Population	2.1 Population (1998 Census)		nos	1,803,258	96,330	90,454	51,405	59,248	87,557	43,284	50,453	53,378	43,255
		2.2 Population Density		person/ha	78.1	256.5	420.9	232.7	273.3	720.3	157.7	451.5	227.3	120.6
	3. Building	3.1 Number of Building		nos	154,315	3,836	2,388	2,752	2,317	1,900	2,965	2,467	2,528	4,654
		3.2 Number of Building by Grid		nos	154,032	3,396	2,206	3,124	2,169	1,884	2,933	2,739	2,585	4,696
			Ratio of Old Brick Masonry (at CASBAH	%	1.0	0.0	0.0	0.0	0.0	0.0	0.0	35.7	0.0	0.0
			Ratio of Stone and Brick Masonry	%	33.6	77.4	66.0	72.4	12.5	75.5	37.5	64.3	46.7	25.0
			Ratio of RC Frame Pre-code	%	40.6	20.8	30.0	13.8	75.0	18.4	50.0	0.0	53.3	41.7
			Ratio of RC Frame Low-code	%	10.0	0.0	4.0	3.4	12.5	4.1	8.3	0.0	0.0	4.2
			Ratio of RC Frame Medium-code	%	1.7	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2
			Ratio of RC Frame High-code	%	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Ratio of Steel	%	0.9	0.0	0.0	0.0	0.0	2.0	4.2	0.0	0.0	0.0
			Ratio of RC Wall	%	11.9	0.0	0.0	10.3	0.0	0.0	0.0	0.0	0.0	25.0
		3.3 Number of Household		nos	300,438	17,888	15,469	8,283	9,807	14,160	7,341	9,326	9,138	7,296
	4. Road Network	4.1 Road Length		km	2,640.21	71.52	38.96	37.91	44.97	28.08	36.13	16.20	40.59	59.95
			Ratio of less than 4m width	%	-	6.1	7.8	4.7	17.1	6.6	18.1	5.9	25.8	11.9
			Ratio of 4-6m width	%	-	27.3	28.4	33.9	29.0	23.5	36.4	12.7	32.8	26.9
			Ratio of 6- 8m width	%	-	20.9	25.8	30.2	20.5	39.8	27.0	30.1	14.5	34.1
			Ratio of 8- 12m width	%	-	35.2	24.5	20.5	30.7	25.9	18.3	37.3	22.0	26.2
			Ratio of over 12m width	%	-	10.5	13.5	10.7	2.7	4.2	0.2	14.0	4.9	0.9
		4.2 Road Density		km/ha	-	0.19	0.18	0.17	0.21	0.23	0.13	0.14	0.17	0.17
		4.3 Bridges		nos	147	11	4	1	1	0	7	1	1	3
	5. Water Supply Pipeline Length by Grid			km	2,148.2	83.6	61.2	55.1	50.4	37.9	45.8	36.7	36.7	69.0
	6. Electric Power Supply Cable (High, Medium Voltage) Length by Grid			km	795.2	59.8	40.9	22.8	42.4	10.8	11.1	13.0	14.0	22.8
	7. Gas Supply Pipeline (Medium Pressure) Length by Grid			km	776.8	12.0	9.7	15.2	15.1	11.0	23.6	7.7	13.9	28.6
	8. Open space (public parks and open-air sports fields)	8.1 Number		nos	250	17	5	5	2	14	8	6	6	10
		8.2 Area		ha	356	27.4	3.2	1.8	3.6	9.4	1.8	2.9	2.0	5.7
		8.3 Area per Resident		m^2/person	2.0	2.8	0.4	0.4	0.6	1.1	0.4	0.6	0.4	1.3
B. Estimated Earthquake Motions and Related Hazard	1. PGA (Max./Min.)	1.1 Khair al Din		(gal)	1200/295	970/424	596/431	748/412	861/416	441/435	610/429	535/435	784/426	655/364
		1.2 Zemmouri		(gal)	1141/122	508/188	282/198	422/210	486/221	219/201	276/188	270/202	348/188	328/181
	2. Seismic Intensity (Max./Min.)	2.1 Khair al Din		(MSK)	9.8/7.9	9.5/8.4	8.9/8.4	9.2/8.4	9.4/8.4	8.5/8.5	8.9/8.4	8.7/8.5	9.3/8.4	9.0/8.2
		2.2 Zemmouri		(MSK)	9.8/6.7	8.7/7.3	7.9/7.4	8.4/7.5	8.6/7.5	7.5/7.4	7.8/7.3	7.8/7.4	8.2/7.3	8.1/7.3
	3. High Liquefaction Potential	3.1 Khair al Din		%	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		3.2 Zemmouri		%	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4. High Slope Failure Potential	4.1 Khair al Din		%	0.3	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0
		4.2 Zemmouri		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. Summary of Estimated Damage	1. Heavily Damaged/Collapsed Building	1.1 Khair al Din		nos	55,817	1,395	922	1,435	834	616	899	1,067	978	1,249
		1.2 Zemmouri		nos	29,176	379	235	492	265	155	212	282	246	331
	2. Heavily Damaged/Collapsed Total Floor Area	2.1 Khair al Din		1000 m^2	10,681	429	289	194	223	135	115	170	141	166
		2.2 Zemmouri		1000 m^2	6,250	128	74	68	70	34	27	47	35	44
	3. Debris of Heavily Damaged/Collapsed Building	3.1 Khair al Din		1000 ton	49,010	2,556	1,765	907	1,123	922	483	774	616	756
		3.2 Zemmouri		1000 ton	28,128	763	450	316	350	231	115	212	154	199
	4. Human Death	4.1 Khair al Din		nos	12,011	875	752	502	398	541	218	492	403	190
				%	0.67	0.91	0.83	0.98	0.67	0.62	0.50	0.97	0.75	0.44
		4.2 Zemmouri		nos	4,568	185	138	125	78	82	0	78	47	0
				%	0.25	0.19	0.15	0.24	0.13	0.09	0.00	0.15	0.09	0.00
	5. Heavy/Slightly Injury	5.1 Khair al Din		nos	54,742	3,061	2,775	2,138	1,841	2,242	1,244	2,108	1,854	1,136
				%	3.0	3.2	3.1	4.2	3.1	2.6	2.9	4.2	3.5	2.6
		5.2 Zemmouri		nos	25,158	1,116	916	858	641	665	0	640	464	0
				%	1.4	1.2	1.0	1.7	1.1	0.8	0.0	1.3	0.9	0.0
	6. Homeless Victims	6.1 Khair al Din		nos	642,088	38,820	37,129	23,093	22,351	28,083	13,026	19,133	19,755	11,294
				%	36	40	41	45	38	32	30	38	37	26
		6.2 Zemmouri		nos	311,121	10,532	9,490	7,974	7,184	7,126	3,122	5,150	5,058	3,046
				%	17	11	10	16	12	8	7	10	9	7
	7. Possibility of Bridge Fall Down (High+Medium)	7.1 Khair al Din		nos	22	1	3	0	0	0	0	0	0	0
				%	15.0%	9.1%	75.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		7.2 Zemmouri		nos	11	0	0	0	0	0	0	0	0	0
				%	7.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	8. Damage of Water Supply Pipeline	7.1 Khair al Din		points	3,965	92	91	50	82	53	71	42	50	65
		7.2 Zemmouri		points	1,636	2	0	1	3	0	0	0	0	0
	9. Damage of Electric Power Cable (Medium Voltage)	8.1 Khair al Din		m	1,664	208	80	52	81	16	15	19	27	35
		8.2 Zemmouri		m	546	15	0	7	3	0	0	0	1	0
	10. Damage of Gas Supply Pipeline (Medium Pressure)	9.1 Khair al Din		points	78	0	0	0	1	0	0	0	0	0
		9.2 Zemmouri		points	42	0	0	0	0	0	0	0	0	0

Table 6-13 (b) Summary of Damage in Each Commune

Items				Unit	Total of 34 Communes	1610 EL BIAR	1611 BOUZAREAH	1612 BIRKHADEM	1613 EL HARRACH	1615 OUED SMAR	1616 BOUROUBA	1617 HUSSEIN DEY	1618 KOUBA	1619 BACH DJERAH
A. Basic Information	1. Area of Commune			ha	23,083.9	418.9	1,260.3	891.7	971.7	806.3	355.3	428.9	1,011.1	335.5
	2. Population	2.1 Population (1998 Census)		nos	1,803,258	52,584	69,152	55,083	48,167	21,396	77,496	49,921	105,253	90,073
		2.2 Population Density		person/ha	78.1	125.5	54.9	61.8	49.6	26.5	218.1	116.4	104.1	268.5
	3. Building	3.1 Number of Building		nos	154,315	7,606	9,578	6,348	4,442	3,193	5,222	4,326	9,573	5,337
		3.2 Number of Building by Grid		nos	154,032	7,408	9,804	6,459	4,560	3,455	4,808	4,630	8,940	6,041
			Ratio of Old Brick Masonry (at CASBAH	%	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			Ratio of Stone and Brick Masonry	%	33.6	33.3	15.8	31.3	55.6	0.0	25.6	46.4	25.0	18.0
			Ratio of RC Frame Pre-code	%	40.6	56.7	68.4	65.6	37.0	91.7	62.8	39.3	35.7	48.0
			Ratio of RC Frame Low-code	%	10.0	6.7	2.6	0.0	0.0	8.3	4.7	3.6	10.7	12.0
			Ratio of RC Frame Medium-code	%	1.7	0.0	2.6	0.0	3.7	0.0	4.7	0.0	0.0	0.0
			Ratio of RC Frame High-code	%	0.4	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0
			Ratio of Steel	%	0.9	0.0	0.0	0.0	0.0	0.0	0.0	3.6	1.8	0.0
			Ratio of RC Wall	%	11.9	3.3	10.5	3.1	3.7	0.0	2.3	3.6	26.8	22.0
		3.3 Number of Household		nos	300,438	9,182	11,362	8,833	7,645	3,309	12,291	8,139	18,095	14,408
	4. Road Network	4.1 Road Length		km	2,640.21	76.17	154.07	111.21	97.39	74.02	31.92	57.02	126.10	46.99
			Ratio of less than 4m width	%	-	8.3	14.2	13.9	4.0	7.1	0.2	1.7	4.8	10.5
			Ratio of 4-6m width	%	-	45.6	34.8	33.0	29.2	17.7	18.7	21.8	35.6	28.7
			Ratio of 6- 8m width	%	-	22.5	24.0	22.5	24.5	14.5	32.6	22.2	32.6	27.7
			Ratio of 8- 12m width	%	-	22.4	24.7	27.4	32.2	29.3	35.7	50.5	23.6	27.0
			Ratio of over 12m width	%	-	1.2	2.3	3.2	10.1	31.4	12.8	3.8	3.4	6.1
		4.2 Road Density		km/ha	-	0.18	0.12	0.12	0.10	0.09	0.09	0.13	0.12	0.14
		4.3 Bridges		nos	147	0	1	4	16	3	2	17	9	5
	5. Water Supply Pipeline Length by Grid			km	2,148.2	81.7	126.0	103.3	70.8	31.4	51.7	54.5	147.5	58.1
	6. Electric Power Supply Cable (High, Medium Voltage) Length by Grid			km	795.2	33.1	45.4	4.3	24.7	11.8	4.8	38.6	70.1	30.7
	7. Gas Supply Pipeline (Medium Pressure) Length by Grid			km	776.8	17.7	52.3	27.9	34.8	30.1	17.2	27.3	53.9	22.3
	8. Open space (public parks and open-air sports fields)	8.1 Number		nos	250	11	6	2	8	5	2	11	16	3
		8.2 Area		ha	356	5.0	3.0	2.0	8.2	5.8	11.9	10.6	12.4	4.5
		8.3 Area per Resident		m^2/person	2.0	0.9	0.4	0.4	1.7	2.7	1.5	2.1	1.2	0.5
B. Estimated Earthquake Motions and Related Hazard	1. PGA (Max./Min.)	1.1 Khair al Din		(gal)	1200/295	989/434	849/426	677/328	691/371	726/359	666/377	978/417	766/330	674/390
		1.2 Zemmouri		(gal)	1141/122	411/185	358/157	382/174	610/326	871/372	500/264	581/238	438/191	516/264
	2. Seismic Intensity (Max./Min.)	2.1 Khair al Din		(MSK)	9.8/7.9	9.6/8.5	9.4/8.4	9.1/8.1	9.1/8.2	9.2/8.2	9.0/8.3	9.6/8.4	9.2/8.1	9.1/8.3
		2.2 Zemmouri		(MSK)	9.8/6.7	8.4/7.3	8.2/7.1	8.3/7.2	8.9/7.2	9.4/8.2	8.6/7.8	8.9/7.7	8.5/7.4	8.7/7.8
	3. High Liquefaction Potential	3.1 Khair al Din		%	0.2	0.0	0.0	0.0	3.0	0.0	1.8	0.0	0.0	0.0
		3.2 Zemmouri		%	0.2	0.0	0.0	0.0	3.0	0.0	1.8	0.0	0.0	0.0
	4. High Slope Failure Potential	4.1 Khair al Din		%	0.3	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		4.2 Zemmouri		%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. Summary of Estimated Damage	1. Heavily Damaged/Collapsed Building	1.1 Khair al Din		nos	55,817	3,393	2,633	1,852	2,076	1,339	1,892	2,155	2,884	1,895
		1.2 Zemmouri		nos	29,176	820	454	617	1,555	1,352	1,259	1,024	1,195	1,119
	2. Heavily Damaged/Collapsed Total Floor Area	2.1 Khair al Din		1000 m^2	10,681	414	386	356	562	438	262	457	458	275
		2.2 Zemmouri		1000 m^2	6,250	100	67	118	430	474	173	212	186	163
	3. Debris of Heavily Damaged/Collapsed Building	3.1 Khair al Din		1000 ton	49,010	1,867	1,612	1,451	2,449	1,849	1,107	2,172	2,207	1,240
		3.2 Zemmouri		1000 ton	28,128	453	278	481	1,872	2,001	731	1,009	897	734
	4. Human Death	4.1 Khair al Din		nos	12,011	489	352	273	401	99	453	459	658	599
				%	0.67	0.93	0.51	0.50	0.83	0.46	0.58	0.92	0.63	0.67
		4.2 Zemmouri		nos	4,568	64	2	43	282	100	278	180	231	325
				%	0.25	0.12	0.00	0.08	0.59	0.47	0.36	0.36	0.22	0.36
	5. Heavy/Slightly Injury	5.1 Khair al Din		nos	54,742	2,102	1,696	1,438	1,848	747	1,999	2,014	2,545	2,397
				%	3.0	4.0	2.5	2.6	3.8	3.5	2.6	4.0	2.4	2.7
		5.2 Zemmouri		nos	25,158	564	61	436	1,470	755	1,455	1,094	1,289	1,610
				%	1.4	1.1	0.1	0.8	3.1	3.5	1.9	2.2	1.2	1.8
	6. Homeless Victims	6.1 Khair al Din		nos	642,088	23,570	18,178	15,489	21,489	8,214	30,008	22,747	33,329	27,670
				%	36	45	26	28	45	38	39	46	32	31
		6.2 Zemmouri		nos	311,121	5,785	3,206	5,248	16,106	8,290	19,979	10,838	13,812	16,319
				%	17	11	5	10	33	39	26	22	13	18
	7. Possibility of Bridge Fall Down (High+Medium)	7.1 Khair al Din		nos	22	0	0	0	4	0	1	8	0	0
				%	15.0%	0.0%	0.0%	0.0%	25.0%	0.0%	50.0%	47.1%	0.0%	0.0%
		7.2 Zemmouri		nos	11	0	0	0	4	0	1	1	0	0
				%	7.5%	0.0%	0.0%	0.0%	25.0%	0.0%	50.0%	5.9%	0.0%	0.0%
	8. Damage of Water Supply Pipeline	7.1 Khair al Din		points	3,965	202	77	84	136	57	113	241	347	137
		7.2 Zemmouri		points	1,636	13	0	2	120	59	76	91	68	50
	9. Damage of Electric Power Cable (Medium Voltage)	8.1 Khair al Din		m	1,664	106	62	3	40	20	10	93	119	60
		8.2 Zemmouri		m	546	4	0	0	25	27	6	31	18	27
	10. Damage of Gas Supply Pipeline (Medium Pressure)	9.1 Khair al Din		points	78	0	4	1	0	0	15	1	2	13
		9.2 Zemmouri		points	42	0	0	0	0	0	8	0	1	3

Table 6-13 (c) Summary of Damage in Each Commune

Category	Items		Unit	Total of 34 Communes	1620 DAR EL BEIDA	1621 BAB EZZOUAR	1622 BEN AKNOUN	1623 DELY BRAHIM	1624 HAMMAMET	1625 RAIS HAMIDOU	1626 DJASR KACENTINA	1627 EL MOURADIA	1628 HYDRA
A. Basic Information	1. Area of Commune		ha	23,083.9	2,357.4	816.6	369.4	838.4	860.4	499.6	1,443.8	191.1	743.5
	2. Population	2.1 Population (1998 Census)	nos	1,803,258	44,752	92,158	19,406	30,577	19,650	21,517	82,730	29,503	35,727
		2.2 Population Density	person/ha	78.1	19.0	112.9	52.5	36.5	22.8	43.1	57.3	154.4	48.0
	3. Building	3.1 Number of Building	nos	154,315	8,366	5,519	3,136	3,877	2,179	3,410	3,427	3,253	7,135
		3.2 Number of Building by Grid	nos	154,032	8,094	5,138	3,299	3,813	2,223	3,364	3,458	3,277	6,980
		Ratio of Old Brick Masonry (at CASBAH	%	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Ratio of Stone and Brick Masonry	%	33.6	0.0	3.9	9.1	0.0	18.2	41.7	10.9	84.8	0.0
		Ratio of RC Frame Pre-code	%	40.6	44.0	21.6	54.5	82.4	81.8	41.7	37.0	6.1	75.0
		Ratio of RC Frame Low-code	%	10.0	32.0	15.7	0.0	5.9	0.0	0.0	10.9	0.0	0.0
		Ratio of RC Frame Medium-code	%	1.7	0.0	7.8	0.0	0.0	0.0	0.0	0.0	0.0	5.0
		Ratio of RC Frame High-code	%	0.4	0.0	2.0	0.0	11.8	0.0	0.0	0.0	0.0	0.0
		Ratio of Steel	%	0.9	8.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0
		Ratio of RC Wall	%	11.9	16.0	49.0	36.4	0.0	0.0	16.7	39.1	9.1	20.0
		3.3 Number of Household	nos	300,438	7,025	15,370	3,371	4,992	3,406	3,556	13,446	5,176	6,429
	4. Road Network	4.1 Road Length	km	2,640.21	181.02	106.93	41.39	85.24	106.31	76.25	125.63	35.78	96.67
		Ratio of less than 4m width	%	-	3.8	13.5	2.5	4.5	19.6	32.3	13.9	8.8	8.9
		Ratio of 4-6m width	%	-	21.2	24.4	31.3	20.5	42.3	28.7	26.3	47.0	29.3
		Ratio of 6- 8m width	%	-	25.4	29.6	23.9	35.4	20.0	19.4	16.8	20.3	41.5
		Ratio of 8- 12m width	%	-	38.2	29.3	40.3	33.9	17.0	18.4	29.3	22.0	18.9
		Ratio of over 12m width	%	-	11.4	3.2	2.0	5.7	1.1	1.2	13.7	1.9	1.4
		4.2 Road Density	km/ha	-	0.08	0.13	0.11	0.10	0.12	0.15	0.09	0.19	0.13
		4.3 Bridges	nos	147	14	6	5	3	0	6	8	0	6
	5. Water Supply Pipeline Length by Grid		km	2,148.2	65.1	55.5	41.0	92.0	29.1	38.8	129.1	55.3	77.8
	6. Electric Power Supply Cable (High, Medium Voltage) Length by Grid		km	795.2	20.2	26.7	35.0	5.4	7.7	6.3	19.2	17.3	39.2
	7. Gas Supply Pipeline (Medium Pressure) Length by Grid		km	776.8	28.6	23.4	19.5	18.3	14.3	15.7	21.2	13.8	29.1
	8. Open space (public parks and open-air sports fields)	8.1 Number	nos	250	5	9	10	10	3	5	2	1	6
		8.2 Area	ha	356	6.5	24.9	31.2	75.1	0.8	1.2	9.3	0.4	5.3
		8.3 Area per Resident	m^2/person	2.0	1.5	2.7	16.1	24.5	0.4	0.5	1.1	0.1	1.5
B. Estimated Earthquake Motions and Related Hazard	1. PGA (Max./Min.)	1.1 Khair al Din	(gal)	1200/295	854/356	795/367	645/460	741/424	839/427	835/429	668/295	758/416	696/387
		1.2 Zemmouri	(gal)	1141/122	1050/417	938/373	247/183	269/156	278/144	340/169	469/209	366/201	317/178
	2. Seismic Intensity (Max./Min.)	2.1 Khair al Din	(MSK)	9.8/7.9	9.4/8.2	9.3/8.2	9.0/8.5	9.2/8.4	9.3/8.4	9.3/8.4	9.0/7.9	9.2/8.4	9.1/8.3
		2.2 Zemmouri	(MSK)	9.8/6.7	9.6/8.4	9.5/8.3	7.7/7.3	7.8/7.1	7.9/7.0	8.1/7.2	8.6/7.5	8.2/7.4	8.0/7.3
	3. High Liquefaction Potential	3.1 Khair al Din	%	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		3.2 Zemmouri	%	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4. High Slope Failure Potential	4.1 Khair al Din	%	0.3	0.0	0.0	0.0	0.0	2.7	6.7	0.0	0.0	0.0
		4.2 Zemmouri	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. Summary of Estimated Damage	1. Heavily Damaged/Collapsed Building	1.1 Khair al Din	nos	55,817	2,941	1,490	1,009	1,309	687	1,047	785	1,675	1,967
		1.2 Zemmouri	nos	29,176	3,848	1,531	166	198	98	200	424	512	417
	2. Heavily Damaged/Collapsed Total Floor Area	2.1 Khair al Din	1000 m^2	10,681	652	321	151	258	111	148	342	238	212
		2.2 Zemmouri	1000 m^2	6,250	860	334	25	39	16	28	190	72	46
	3. Debris of Heavily Damaged/Collapsed Building	3.1 Khair al Din	1000 ton	49,010	2,795	1,800	707	1,185	495	626	1,694	1,013	983
		3.2 Zemmouri	1000 ton	28,128	3,687	1,872	115	180	70	120	941	306	213
	4. Human Death	4.1 Khair al Din	nos	12,011	244	487	76	150	73	69	337	293	172
			%	0.67	0.54	0.53	0.39	0.49	0.37	0.32	0.41	0.99	0.48
		4.2 Zemmouri	nos	4,568	340	502	0	0	0	0	149	40	0
			%	0.25	0.76	0.54	0.00	0.00	0.00	0.00	0.18	0.13	0.00
	5. Heavy/Slightly Injury	5.1 Khair al Din	nos	54,742	1,333	2,094	631	964	615	592	1,647	1,509	1,059
			%	3.0	3.0	2.3	3.3	3.2	3.1	2.8	2.0	5.1	3.0
		5.2 Zemmouri	nos	25,158	1,660	2,138	0	0	0	0	961	415	0
			%	1.4	3.7	2.3	0.0	0.0	0.0	0.0	1.2	1.4	0.0
	6. Homeless Victims	6.1 Khair al Din	nos	642,088	15,990	26,219	5,885	10,347	6,032	6,662	18,408	14,754	9,885
			%	36	36	28	30	34	31	31	22	50	28
		6.2 Zemmouri	nos	311,121	20,895	26,943	978	1,585	866	1,277	9,988	4,597	2,133
			%	17	47	29	5	5	4	6	12	16	6
	7. Possibility of Bridge Fall Down (High+Medium)	7.1 Khair al Din	nos	22	0	0	0	0	0	0	1	0	0
			%	15.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	12.5%	0.0%	0.0%
		7.2 Zemmouri	nos	11	1	0	0	0	0	0	0	0	0
			%	7.5%	7.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	8. Damage of Water Supply Pipeline	7.1 Khair al Din	points	3,965	184	151	31	64	16	48	191	66	99
		7.2 Zemmouri	points	1,636	185	154	0	0	0	1	24	3	0
	9. Damage of Electric Power Cable (Medium Voltage)	8.1 Khair al Din	m	1,664	49	66	70	6	11	11	14	39	71
		8.2 Zemmouri	m	546	87	77	0	0	0	0	3	2	0
	10. Damage of Gas Supply Pipeline (Medium Pressure)	9.1 Khair al Din	points	78	2	0	4	0	4	0	0	1	0
		9.2 Zemmouri	points	42	2	0	0	0	0	0	0	0	0

Table 6-13 (d) Summary of Damage in Each Commune

Category	Items		Unit	Total of 34 Communes	1629 MOHAMMADIA	1630 BORDJ EL KIFFAN	1631 EL MAGHARIA	1632 BENI MESSOUS	1639 BORDJ EL BAHRI	1640 EL MARSA	1644 AIN BENIAN
A. Basic Information	1. Area of Commune		ha	23,083.9	793.6	2,107.1	159.0	772.4	758.6	378.0	1,386.1
	2. Population	2.1 Population (1998 Census)	nos	1,803,258	42,079	103,690	30,459	17,489	27,905	8,782	52,345
		2.2 Population Density	person/ha	78.1	53.0	49.2	191.6	22.6	36.8	23.2	37.8
	3. Building	3.1 Number of Building	nos	154,315	4,148	11,010	2,727	2,286	4,797	1,273	6,340
		3.2 Number of Building by Grid	nos	154,032	4,321	10,915	2,643	2,254	4,724	1,330	6,362
		Ratio of Old Brick Masonry (at CASBAH	%	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Ratio of Stone and Brick Masonry	%	33.6	13.0	15.3	11.8	10.0	13.3	20.0	24.1
		Ratio of RC Frame Pre-code	%	40.6	34.8	18.6	58.8	50.0	66.7	80.0	44.8
		Ratio of RC Frame Low-code	%	10.0	30.4	49.2	5.9	30.0	13.3	0.0	24.1
		Ratio of RC Frame Medium-code	%	1.7	0.0	10.2	0.0	0.0	0.0	0.0	0.0
		Ratio of RC Frame High-code	%	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Ratio of Steel	%	0.9	0.0	3.4	0.0	0.0	0.0	0.0	0.0
		Ratio of RC Wall	%	11.9	21.7	3.4	23.5	10.0	6.7	0.0	6.9
		3.3 Number of Household	nos	300,438	6,928	16,136	5,055	2,895	4,465	1,470	8,746
	4. Road Network	4.1 Road Length	km	2,640.21	98.29	193.39	20.06	85.85	79.89	33.37	124.94
		Ratio of less than 4m width	%	-	9.6	18.7	8.2	18.2	17.6	4.2	12.5
		Ratio of 4-6m width	%	-	24.8	30.0	39.3	29.8	24.1	15.6	31.2
		Ratio of 6- 8m width	%	-	30.0	20.7	17.9	24.5	19.0	23.4	22.9
		Ratio of 8- 12m width	%	-	29.9	19.0	30.9	23.2	22.8	31.2	28.4
		Ratio of over 12m width	%	-	5.7	11.6	3.7	4.3	16.5	25.6	5.0
		4.2 Road Density	km/ha	-	0.12	0.09	0.13	0.11	0.11	0.09	0.09
		4.3 Bridges	nos	147	7	2	2	0	0	0	2
	5. Water Supply Pipeline Length by Grid		km	2,148.2	37.8	108.5	23.3	36.0	54.7	24.5	78.3
	6. Electric Power Supply Cable (High, Medium Voltage) Length by Grid		km	795.2	16.0	26.1	12.8	7.2	23.2	8.3	23.5
	7. Gas Supply Pipeline (Medium Pressure) Length by Grid		km	776.8	30.4	46.0	12.0	16.5	29.9	12.4	25.4
	8. Open space (public parks and open-air sports fields)	8.1 Number	nos	250	11	24	2	7	8	1	9
		8.2 Area	ha	356	17.5	25.9	3.7	3.7	18.5	0.7	10.1
		8.3 Area per Resident	m^2/person	2.0	4.2	2.5	1.2	2.1	6.6	0.8	1.9
B. Estimated Earthquake Motions and Related Hazard	1. PGA (Max./Min.)	1.1 Khair al Din	(gal)	1200/295	961/489	1047/431	776/454	796/434	867/435	848/435	1200/434
		1.2 Zemmouri	(gal)	1141/122	777/372	1141/390	510/300	282/146	922/463	902/463	340/122
	2. Seismic Intensity (Max./Min.)	2.1 Khair al Din	(MSK)	9.8/7.9	9.5/8.6	9.6/8.5	9.2/8.5	9.3/8.5	9.4/8.5	9.4/8.5	9.8/8.5
		2.2 Zemmouri	(MSK)	9.8/6.7	9.2/8.2	9.8/8.3	8.7/8.0	7.9/7.0	9.5/8.5	9.4/8.5	8.1/6.7
	3. High Liquefaction Potential	3.1 Khair al Din	%	0.2	0.0	0.3	0.0	0.0	0.0	0.0	0.0
		3.2 Zemmouri	%	0.2	0.0	0.5	0.0	0.0	0.0	0.0	0.0
	4. High Slope Failure Potential	4.1 Khair al Din	%	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		4.2 Zemmouri	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C. Summary of Estimated Damage	1. Heavily Damaged/Collapsed Building	1.1 Khair al Din	nos	55,817	1,671	4,637	974	821	1,799	504	2,986
		1.2 Zemmouri	nos	29,176	1,304	4,911	493	125	2,022	556	385
	2. Heavily Damaged/Collapsed Total Floor Area	2.1 Khair al Din	1000 m^2	10,681	409	1,136	151	204	347	108	423
		2.2 Zemmouri	1000 m^2	6,250	319	1,200	77	31	390	120	53
	3. Debris of Heavily Damaged/Collapsed Building	3.1 Khair al Din	1000 ton	49,010	1,900	4,858	631	816	1,420	440	1,791
		3.2 Zemmouri	1000 ton	28,128	1,482	5,131	325	124	1,599	491	226
	4. Human Death	4.1 Khair al Din	nos	12,011	300	796	167	65	147	3	479
			%	0.67	0.71	0.77	0.55	0.37	0.53	0.03	0.91
		4.2 Zemmouri	nos	4,568	218	847	49	0	173	10	0
			%	0.25	0.52	0.82	0.16	0.00	0.62	0.11	0.00
	5. Heavy/Slightly Injury	5.1 Khair al Din	nos	54,742	1,532	2,881	1,039	568	953	69	2,072
			%	3.0	3.6	2.8	3.4	3.2	3.4	0.8	4.0
		5.2 Zemmouri	nos	25,158	1,243	2,998	475	0	1,066	169	0
			%	1.4	3.0	2.9	1.6	0.0	3.8	1.9	0.0
	6. Homeless Victims	6.1 Khair al Din	nos	642,088	15,938	43,340	11,043	6,338	10,480	3,329	24,061
			%	36	38	42	36	36	38	38	46
		6.2 Zemmouri	nos	311,121	12,449	45,916	5,667	973	11,754	3,672	3,166
			%	17	30	44	19	6	42	42	6
	7. Possibility of Bridge Fall Down (High+Medium)	7.1 Khair al Din	nos	22	3	1	0	0	0	0	0
			%	15.0%	42.9%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		7.2 Zemmouri	nos	11	3	1	0	0	0	0	0
			%	7.5%	42.9%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	8. Damage of Water Supply Pipeline	7.1 Khair al Din	points	3,965	94	378	84	29	206	80	254
		7.2 Zemmouri	points	1,636	89	374	35	0	206	80	0
	9. Damage of Electric Power Cable (Medium Voltage)	8.1 Khair al Din	m	1,664	41	85	30	9	37	15	64
		8.2 Zemmouri	m	546	32	108	12	0	43	18	0
	10. Damage of Gas Supply Pipeline (Medium Pressure)	9.1 Khair al Din	points	78	8	22	0	0	0	0	0
		9.2 Zemmouri	points	42	8	20	0	0	0	0	0

Chapter 7. Existing Social Conditions

7-1 Population and Households

7-1-1 Demography of Algiers

The total population of the Wilaya of Algiers was 2,562,424 at the time of the latest census in 1998. By 31 December 2002, it was estimated to be 2,700,449[1] with a density of 3,337 inhabitants per square kilometer. During the period between the last two censuses (1987-1998) the population increased at an average annual rate of 1.6%, which is lower than the national rate of 2.5%. The highest population density is seen in the center of Algiers.

The results obtained in the two censuses indicate population decrease was recorded in communes in the center of Algiers, for example -1.40% in Bab El Oued and -1.60% in Kasbah, while population growth of more than 8 % is seen in communes in peripheral areas.

7-1-2 Population and Households Profiles

A decline in birth rate affects both total population and population structure, and labor population also declined to 27% of the total population in 1998, in comparison to 34% in 1987. The population aged 60 and more increased in the same period from 5.8% to 8%.

The rate of children between the ages of 6 and 15 attending school is about 91%. The unemployment rate was 23.58%. According to the questionnaire survey, the number of working persons in a house hold averages 1.3, and the total monthly income averages about 25,400 DA.

The percentage of handicapped persons in the Wilaya of Algiers was 7.78% of the total population. Of those people with a handicap, about 2% were in category 1, which should be considered in crisis management. The percentage of households having handicapped people can be estimated to be 15%.

The questionnaires survey indicates that nearly half the households (46%) are composed of two or more families. The number of members in a household ranges from 1 to 36, with an average of 8.4 per household. About two-thirds of householders live in detached houses, and the remainder (35%) in collective houses. The ground area of the households is about 500 m^2 on average, and the mode value is about 200 m^2.

Piped water supply to each house as a public service is dominant (more than 95%). However, the piped water is not always available, and thereby, water tanks are installed at 38% of households. Availability of other public services is also high, with electricity at 98%, sewerage at 96%, and piped gas supply at 77%.

7-1-3 The Households Face Seismic Risk in Algiers

Regarding past earthquakes, 99.6% of the surveyed householders remembered the date of the Boumerdes earthquake and 83.8% experienced violent tremors. Specific risks which they are very concerned about are collapse of buildings and walls, and then, risks of damage to

[1] Source: Statistical Yearbook of Algiers Wilaya (2003)

infrastructures. The opinion of the householders on the physical resistance of schools is worse than that of their houses. A total of 62% of the householders intend to reinforce their houses and 34% are willing to share the cost for the reinforcement. The forms of media that are popular with the surveyed households are TV (96%), radio (50%), and local newspapers (46%). Most the householders (94%) think that education in schools regarding earthquakes and risk reduction is an efficient means to teach children.

The social bonding seems to be weak, as the questionnaire indicated that the frequency of visits to neighbors is “rare or none” for 53% of the interviewees and “daily” for only 15%. Participation in the activities of local groups is not common, and only 12% of the households attend meetings for culture (4.6%), street cleaning (3.2%), sports (2.6%), and mutual aid (1.4%).

7-2 Land-use and Urban Development

7-2-1 General Considerations of the Algiers Metropolis

Historically, development of Algiers started initially in Casba. In the colonial period from 1830 to 1962, European dwellings expanded to eastern areas with flat topography and soft soil. Shortly after independence, infrastructures were developed rapidly based largely on economic advances led by the hydrocarbon industry. Algiers is today facing complex urban issues on housing, traffic, and infrastructures, requiring urgent measures. Together with development of infrastructures, the need for risk reduction and preservation of the environment have recently been emphasized.

7-2-2 Recent Situation in Urban Planning and Administrative Organization

As mentioned in the previous section, the Wilaya of Algiers is presently divided into fifty-seven (57) Communes chaired by the President of the Popular Communal Assembly. Each Commune is a part of one of the thirteen (13) Daira, chaired by a Wali delegate.

7-2-3 Land-use Development Planning and Environmental Preservation Planning

There are two main instruments for land-use and urban planning.

- **PDAU** (*Plan directeur d’aménagement et d’urbanisme*): Master Plan for Land-use and Urban planning, to be implemented at communal and inter-communal levels. This is presented on maps at the scale of 1/5,000 (1/10,000 for the Greater Algiers)
- **POS** (*Plan d’occupation des sols*): Land-use Plans (generally five to ten POS per commune) are presented on a scale of 1/500 (Urban Composition Plans)

A new PDAU of Algiers is under preparation. The new PDAU, covering the Wilaya of Algiers (57 communes) should be consistent with the following requirements imposed by laws n° 04-05 and n° 04-06.

- Global approach (participation of the citizens), - Environmental criteria, - Sustainable development, - Consideration of natural and technological hazards

The Wilaya of Algiers is divided into 500 areas for POS, and 126 POS have been prepared to date. The POS gives the orientation of land-use and detailed implementation plans.

7-3 Risk Perception and Culture in Algiers - Social Factors of Vulnerability and Resilience

7-3-1 General Consideration

Through the past disasters, people in Algiers have reaffirmed the reality of natural disaster risk, and the necessity of preparation for efficient disaster management, especially as regards physical constructs. Vulnerability is firstly a matter of physical resilience on buildings and infrastructures. Also, vulnerability is a psychological matter. The psychological disturbance may intensify and expand to a degree that independently damages human life and social functioning as well as governance. For the reduction of both physical and psychological risks, awareness and preparedness regarding disaster management are essential.

7-3-2 Viewpoints Expressed by the Different Stakeholders

1/ Politicians and the elected representatives recommend placing priority on the measures relating to vulnerability reduction. They also speak about the importance of urban management, security of the manufacturing sector, and the development of a culture that is devoted to risk reduction.

2/ Administrators of the Wilaya emphasize widespread carelessness which leads to illegal construction and uncontrolled urban expansion. They are aware of the importance of information, especially documents for disaster management. They stress the need to inform the population about natural disaster management and to ensure that the media fulfills its proper role in disaster mitigation. But no one is taking any action.

3/ The presidents of APC state that the commune does not have staff or budget for risk management. There is almost no capacity for risk reduction or emergency response at a local level. They emphasize 1): the need for preparation and mobilization of the civil society to increase capacity on crisis management, 2): the necessity of training for the personnel of construction companies, and 3); rigorous management of urban planning and construction at the local level.

4/ Religious leaders (Imams) agree on introducing scientific viewpoints on natural disasters, and express a special interest in disaster management or prevention without relying on fatalism. Religious men could play an important role in awareness for disaster mitigation if the Imams were given preliminary training. They usually advise people to have life or automobile insurance, but not natural disasters insurance, because it is not well known.

5/ Crisis managers and 6/ Police and Civil Protection became aware of the importance of involvement of civil society through the lessons learned during the last disaster management efforts. For good collaboration, each one should have a scope and task for intervention. The civil protection must play a role in coordination and monitoring the collaboration. Although the officers have a great deal of experience in disaster management, they are concerned with the lack of availability of technical resources. Addressing this deficiency will require better utilization of the potential human resources. A culture of risk reduction and willingness to engage in voluntary activities should be promoted.

7/ Public services think that in an emergency they have responsibility for restoring ordinary life rapidly and efficiently. Through the experience of the past disaster, they became aware that their intervening capacity is insufficient, and they are requesting that the State regulate their role to allow them to provide more efficient intervention. They think that involvement of the population is important for risk reduction as well as crisis management.

8/ Health services are aware that they do not have sufficient training for response in a crisis. They request information and training for better crisis management and prevention. They consider their role as suitable for the expansion of a prevention culture.

9/ School Teachers and Directors of primary schools think that they do not have adequate training, because there is no national-level initiative in disaster management education. During last disaster, schools provided refuge for the homeless. Teachers suspect that many school buildings do not meet the requirements of the new building codes.

10/ University professors focus on the dangers emanating from the industrial factories in the urban areas. Lectures on risk management have been started in studies of the social sciences, but these lectures are not popular. In the scientific field, programs on risk management are mostly on the issues of buildings. The educators express an optimistic opinion regarding the State policy for global risk management and integrating a national-level land use plan. They also expressed an opinion that the Algerian system for risk reduction should be greatly enhanced.

11/ Economic actors, they agree to invest in disaster management for things such as staff training and applying seismic standards in order to make their businesses more secure. The management of all the big hotels have agreed to ensure their clients' security. However it seems as though they have not taken sufficient measures in this regard nor have they prepared an adequate plan for disaster management.

12/ Insurance companies stated that issuance was not popular in Algeria. After the last disasters, some people have purchased business or home insurance. Ordnance 03-12 prescribes that all inhabitants of Algeria should have natural disaster insurance and an insurance certificate is required for application for registration as a resident.

13/ Media people recognize that they have a fundamental role in major risk reduction as well as crisis management. However, there is neither concrete policy nor strategy agreed among the media about their roles/activities in an emergency situation. Overblown or incorrect news dispersed by some media might cause confusion and panic within society. The Environmental Press Club can arrange discussions of such issues among the media.

14/ District Committees stand in a position to relay information in campaigns for raising awareness of the local population in disaster management. They are encouraging the local youth to participate in the activities and campaigns. They request special training for sharing information on disaster mitigation with the local population and for adequate preparation for response to any future disasters.

15/ NGOs state that their activities in preparation for and during crisis include coordinating volunteers, fund-raising, organizing solidarity chain, supplying emergency materials, and psychological care. Major NGOs are the Algerian Red Crescent and the Algerian Muslim Scouts. They request 1) reinforcement for their coordination activities, 2) establishment of local plans, 3) simulations and training, 4) restoration of decayed buildings, 5) raising awareness, etc. for disaster management.

7-3-3 Social and Community Factors of Vulnerability and Resilience

(1) Factors of governance and sustainability in disaster management

The factors required for good disaster management governance are the quality of the legislative framework, simple decision-making processes, good linkage among organizations, clear definition of roles and responsibilities, good ability of officials, simple legislation system, appropriate local action plans, capacity of mobilization and implementation, etc. The factors required for disaster management sustainability are a comprehensive risk assessment system, the integration of risk reduction in sustainable development planning at the national, regional and urban levels, and participative systems.

Most people recognize the importance of disaster management and also understand the vulnerable condition of Algiers. A remarkable issue is the big gap between theoretical opinions regarding what actions should be taken and the actual implementation/activities. Generally, after a theoretical speech, the speakers express several factors that limit their ability to act. Many interviewees mentioned the necessity of capacity building and proper knowledge regarding disaster management; however, only a few training and education programs have been held in actual fact.

(2) Human and Socio-economic Factors

The human vulnerability factors are related mainly to poverty and the weak, and are also related to solidarity and social bonding. The physical vulnerability comes with socio-economical and psychological vulnerability. The poor suffer more serious damage from natural disasters and fall further into poverty, resulting in an obstacle for development of society as a whole.

It is explained that a good community network and tight social bonding contributed to quick and efficient rescue activity at the time of the Boumerdes earthquake, and the voluntary efforts by the youth were remarkable. The function of district committees was important as some committees acted like local crisis cells. However, some people think that this willingness to volunteer and the social bonding is much greater in Boumerdes than in Algiers. It is necessary to take action to cultivate and promote the willingness to volunteer and to nurture social bonding in order to increase the capacity of the human factor.

(3) Factors of skill and ability

Many people think that activities in disaster management for raising awareness, information dissemination and preparedness are currently not sufficient. No clear mission exists on the role of media in a disaster and there have been only a few media programs for education regarding disaster management. There are only a few classes on disaster management in schools. The lack of local action plans on disaster management is also another crucial point. More globally, the insufficiency in the education and training of important stakeholders is cause for concern and should be rectified.

Chapter 8. Existing Disaster Management System

8-1 Legal Framework for Disaster Management

(1) Formulation of legal framework

Decrees n° 85-231 and n° 85-232 were promulgated on 29 May 1985. The two decrees were the first regulations related to integrated disaster management in Algeria. Decree n° 85-231 defines the organization and procedures for crisis management through implementation of the "Plan of organization of the interventions and assistance (ORSEC Plan)" for Wilayas and Communes. Decree n° 85-232 relates to risk prevention. It is very short and comprises only eleven (11) Articles without detailed description of its objectives, its contents or its implementation.

These two decrees have been the base for disaster management in Algeria for 20 years.

(2) Evolution of legal framework

At present, the most important legal outcome on disaster management is the promulgation of **Law n° 04-20** on 25 December 2004, concerning "Prevention of Major Risks and Crisis Management in the Framework of Sustainable Development". The law establishes a system of risk reduction and crisis management for ten (10) kinds of risks with the following objectives.

- Improvement of knowledge of risks, development of technology, dissemination of risk reduction information, and promotion of training
- Consideration of risks in land-use planning and in the construction process
- Formulation of systematic and integrated, participating citizens, in accordance with local conditions

The National system for crisis management prescribed in the Law is composed of the following two elements.

- Plans for assistance and intervention, adapted for all levels; national, inter-Wilaya, Wilaya and communes, as well as for critical sites defined on ORSEC plans
- Stratified measures for the interventions: specialized institutions, strategic supplies and repair of damaged installations, notably the creation of a "National Delegation on Major Risk", which will be established under the Prime Minister

Law n° 04-20 is the highest level of legal basis for all measures on disaster management at the stages of risk reduction and intervention (emergency response), but it does not deal with rehabilitation and reconstruction, which is a latter stage of the disaster management cycle.

(3) Laws and regulations for the design of buildings

AS55 in 1955 and PS62 to PS69 from 1962 to 1969 presented guidelines and recommendations, but there was no obligation in building design.

The first code of Algerian Earthquake Design Requirements (RPA) appeared as RPA81 in 1981, and was revised in 1983 as RPA83. RPA81 and RPA83 prescribed obligations for public buildings but not for private buildings.

RPA99 was introduced in 1999. The objectives of this code were outlined as requiring "Elastic behavior of a structure in relatively frequent moderate seismic events" and "no collapse or loss of stability while facing rare major seismic events". Seismic design code RPA99 was revised as RPA99/Version 2003 by order of MHU, and it applied to all buildings both public and private.

(4) Laws and regulations for land-use and urban planning for disaster management

Law n° 90-29 of 1 December 1990, concerning land development and urban development, is aimed at regulating suitable land use in the framework of inter-sectoral and environmental balance. This law defines urban development instruments; that include PDAU ("Plan Directeur d'Aménagement et d'Urbanisme", or "Land Development and Urban Development Master Plans" in English) and POS ("Plan d'Occupation des Sols", or "Land Occupation Plans") with spatial and inter-sectorial functions for each category.

Law n° 04-05 of 14 August 2005 amended Law n° 90-29 and supplements it particularly regarding the limitations on land development where natural and technological risks are foreseen.

(5) Other regulations for risk management

The following decrees have been recently promulgated and are important regulations directly related to risk management.

- Executive Decree n° 03-332 of 8 October 2003, regarding creation, organization and operation of the National Operational Centre for Support and Decision (CNAD)
- Executive Decree n° 04-181 of 24 June 2004, regarding creation of the commission on communication related to the major natural and technological risks
- Executive Decree n° 04-268 of 29 August 2004, regarding identification of the natural disasters to be covered by insurance and the methods of declaration of the state of natural disaster

(6) Issues for further evolution

Law n° 04-20 prescribes that implementation mode and detailed procedures will be fixed by other regulations on Information, training, restoration of damaged buildings, strategic buildings, ORSEC plans, crisis management, internal plans, strategic reserves, financial assistance, the National Delegation for Major Risk (DNRM), etc.

It is scheduled that the Law will be followed by at least 10 decrees for implementation. The most important and urgent issue is to launch a new Decree on the establishment of the National Delegation for Major Risks (DNRM). The DNRM will formulate the remaining decrees. Key issues for further evolution will be reinforcement of activities of communities and individuals, raising awareness, involvement of the media, promotion of an insurance system, etc. After the legal framework is established, the DNRM will formulate the national policy and action plans, including guidelines for formulation of disaster management plans for all levels of organizations. The action plan should cover all the disaster management stages (before, during, and after disasters) and secure conformity and continuity with the ORSEC plan.

8-2 Institutional and Organizational Systems

8-2-1 National Level

National level organizations responsible for overall matters on disaster management such as DNRM or CNAD, have not yet begun operation, and specific matters on disaster management are under the responsibility of particular Ministries, such as the Ministry of Housing and Urbanisation (MHU) for buildings and urban planning, the Ministry of the Interior and Local Collectivities (MICL) for mainly emergency response, and the Ministry of Environment and Land-Use Planning (MATE) for mitigation and preparedness. Many Directors in the Ministries and agencies under the authority of the Ministries have tasks for disaster management. Among them, important organizations are the National Earthquake Engineering Centre (CGS; under MHU) for earthquake engineering, the National Organization of Construction Technical Control (CTC; under MHU) for control of building design and construction, the General Director of Civil Protection (DGPC; in MICL) for emergency response, the Research Centre in Astronomy, Astrophysics and Geophysics (CRAAG; under MICL) for earthquake science and education.

8-2-2 Local Level

Algeria applies a centralized administration system, and the central government is involved in Wilaya administration (the first level of local administration), such as nomination of Wali (chief of the Wilaya), and external services of ministerial departments involved in Wilaya services. Although those Wilaya services deal with specific matters in disaster management, there is no organization responsible for overall matters on disaster management in Wilaya. The main organizations which deal with specific matters are the Agency for Planning and Urbanism of the Wilaya of Algiers (URBANIS), the Director of civil protection of Wilaya (DPCW) for emergency response, the Director of Urbanisation and Construction (DUC) for urban planning and development, the Director of land use planning, urbanisation, the prevention and reduction of precarious housing (DATUPRHP), the Director of lodgment (DLW), and other Directors on equipment, public works, hydraulics, and health, etc.

The commune is the smallest administrative unit in Algeria, closest to the citizens, and is chaired by a person elected through direct elections who is called the President of the Communal Popular Assembly (APC). The APC President is responsible for public order, security, safety, and health under authority of the Wali. Concerning disaster management, he is responsible for the formulation of POS (Land use plan), and the transmission of information between the Wilaya and its citizens.

8-2-3 Community and NGOs

There is no definite legal framework for supporting the formation and activity of associations or civil groups concerning risk prevention at present, although Decree n°92-54 mentions a bit about linkage between DPCW and citizens’ relief activities.

The Algerian Red Crescent (CRA) and the Algerian Muslim Scouts (SMA) are major NGOs.

8-3 Disaster Management Plan

The ORSEC plan of the Wilaya of Algiers, formulated in accordance with Decree 85-231, is a substantial disaster management plan on emergency response. The plan describes the present situation of the Wilaya, characteristics of risks, and the disaster management concept in its introduction, and then, explains the framework, mission, and command body. The following chapter explains the implementation mechanism and necessary actions to be taken by the commander. The last part explains the organization and mission of the 14 modules with a list of personnel in charge and stocked materials/equipment. In the near future, an overall plan on disaster management, including risk prevention and rehabilitation plans will be established. And a highly detailed description of the procedure for actions will be prescribed in the new plan.

8-4 Lessons Learnt from Past Disasters

8-4-1 El Asnam Earthquake (10 October 1980)

The El Asnam earthquake (M=7.3) on 10 October 1980 caused serious damage: about 2,600 deaths, and nearly 10,000 injured. More than 20,000 buildings totally collapsed, and more than 100,000 people lost their homes. The cost of the damage was estimated to be 2.0 billion Dollars, and additional indirect loss was about 30% to 40% of the direct losses.

Crisis management by the Wilaya services was not operational, because most types of resources, such as staff, buildings, and facilities, were seriously damaged. The government decided that the Popular National Army (ANP) should take charge of crisis management. The tragic experience is exemplary of Algerian disaster management both for better and for worse.

Through the awful experience, Algerians have become aware of the importance of seismic risks in the country, and made a remarkable step toward comprehensive disaster management, such as establishment of seismic regulation "RPA81" and Decrees n° 85-231 and 85-232 of 25 August 1985.

However, it should be noted that some of the issues have not been resolved yet; especially, 1) the establishment of a national-level organization for comprehensive disaster management, 2) an ORSEC plan (or disaster management plan) for each Ministry, Wilaya, Commune, and major public services, and 3) nation-wide risk mapping, etc.

8-4-2 Bab El Oued Floods (10 November 2001)

On 10 November 2001, huge cloudbursts occurred and caused a heavy muddy flood to rush down the basin slopes. This flood devastated the highly urbanized districts, mostly in the Commune of Bab el Oued, which remained particularly vulnerable due to decayed buildings of the colonial era and rapid urbanization with illegal housing during the last twenty years. The flood resulted in nearly 1,000 dead or missing persons, serious damage to buildings (2,750 totally collapsed or heavily damaged).

At the beginning of the disaster, response operations fell into confusion, including failures in organizational planning. A direct cause of the confusion was the total failure of the communication network due to destruction of the telephone exchange centre of Bab el Oued. Other reasons for the confusion seemed to be 1) malfunction of the alert system, 2) inadequate assessment of the situation in the initial stages, 3) insufficient stocks of rescue and relief materials, etc. These shortcomings were due to a lack of attention to “Major Risk” by services and institutions as well as to a lack of a culture for risk management in Algerian society.

Although there were many failures and difficulties in the initial response, efficient organization was established gradually, and urgent measures were taken by 18 modules, integrated in the operational device, in accordance with the ORSEC plan. Remarkable performance was seen in providing shelter for the victims, clearance of roads, etc. Concerning shelter, 1,544 families in Bab el Oued and 400 families in the neighboring corridor could settle in temporary dwellings at 36 sites in the Wilaya of Algiers by 31 December 2001. Concerning road clearance, all the roads had been restored by 25 January 2002, and access to the city of Bab el Oued fortunately was again made possible.

The Bab el Oued flood revealed the effectiveness of the ORSEC plan as well as its weak points, and the experiences led to further efforts for improvement of disaster management capability, such as the promulgation of Law n° 04-20, and the revision of seismic regulation RPA99-ver. 2002.

8-4-3 Boumerdes Earthquake (21 May 2003)

On Wednesday 21 May 2003 at 7:44 pm, the north-central area of Algeria experienced a powerful earthquake of magnitude 6.8. The origin was located offshore to the north of the city of Zemmouri at approximately 10 km in depth.

This earthquake particularly affected the Wilayas of Boumerdes, Algiers, Tizi Ouzou, Bouira and Blida. The damage to humans were 2,278 deaths, more than 10,000 injured, and 180,000 suffered from direct damage such as losing their homes.

Concerning damage to buildings, approximately 7,400 buildings were totally collapsed and nearly 7,000 others were seriously damaged in the Wilaya of Boumerdes. Not less than 8,500 buildings were lost and more than 20,000 seriously damaged in the Wilaya of Algiers. Although several insufficiencies caused serious damages, it is clear that the updating of Algerian seismic regulation was effective for improving building quality.

Although much improvement and good performance in emergency response were reported in transportation, telecommunications, etc., many issues to be improved were also pointed out, such as 1) assignment of successors for key staff, 2) creation of a national-level organization for disaster management, 3) promotion of insurance, 4) improvement of ORSEC plans and creation of risk reduction plans, 5) Inter-Wilaya cooperation, etc.