Table 1. The temperatures, wind direction and the developmental and human activities of different sampling sites of Riyadh city.

	Jun-06		Nov-06		Feb-07		May-07		
Site	**T (^{o}C)**	**WD**	**T (^{o}C)**	**WD**	**T (^{o}C)**	**WD**	**T (^{o}C)**	**WD**	**Activities**
AM	39-46	W	28	SE	19	NE	ND	ND	No human activities
AQ	44-50	W	34-38	SW	23-25	NW	ND	ND	Uptown area, construction of small housing complexes and buildings
DR	42-45	NE	29-31	E	21-23	NE	ND	ND	Suburban area, open and winds, less traffic
OR	43-45	S	26	SE	16-26	S	ND	ND	Residential area and sewage odor
SH	43-46	S	29-30	S	20-24	NW	ND	ND	Residential area and moderate traffic
AZ	42-43	SW	34-38	S	28	NW	ND	ND	Residential area and less traffic
AL	43-47	NE	34	S	17-21	S	ND	ND	Residential and business area, heavy traffic
NZ	48-50	S	19-21	S	23-27	S	ND	ND	Suburban area, light traffic
JZ	45-46	S	33-34	SW	31	SW	ND	ND	Suburban area
MN	43-46	SW	32	SW	20-23	S	ND	ND	Industrial area, cement and ceramic factories, heavy traffic

WD = Wind direction

AM = Amariah, AQ = Aqiq, DR = Diriyah, OR = Al-Oreja, SH = Al-Shefa, AZ = Azaziah, AL = Oliah, NZ = Nazeem, JZ = Al-Jazirah, MN = Al-Manakh.

Table 2. Aerosol particulate matter concentrations (μg m^{-3}) collected from the city of Riyadh, Saudi Arabia.

	AM	AQ	DR	OR	SH	AL	AZ	NZ	JZ	MN	Mean	SD
						$PM_{2.5}$						
						μg m^{-3}						
June-06	55.6	184.4	136.1	56.7	81.6	14.5	98.5	100.1	101.5	219.5	104.8	61.4
Nov-06	13.7	226.7	106.1	28.1	45.5	58.0	29.0	59.3	70.3	144.9	76.3	66.1
Feb-07	44.4	72.2	141.8	127.0	26.7	145.8	102.6	194.4	180.6	217.7	124.5	62.8
May-07	225.3	115.9	222.2	352.4	196.1	121.2	110.7.	142.9	119.6	257.6	189.4	81.6
						PM_{10}						
June-06	111.1	283.7	173.9	83.3	141.8	58.0	126.8	112.5	231.9	478.2	180.1	124.8
Nov-06	28.6	370.4	130.4	54.0	115.9	124.0	63.5	99.3	154.7	318.8	146.0	112.1
Feb-07	62.0	144.3	180.2	170.0	56.3	468.1	283.7	416.7	361.1	397.1	268.1	164.6
May-07	260.9	145.8	325.6	548.5	279.6	293.3	194.5	250.0	227.0	597.2	312.2	146.8

Table 3. Air Quality Levels [a] of particulate matter of Riyadh.

	2006		*2007*			
	June	**November**	**February**	**May**		
			$PM_{2.5}$			
Site					**Mean**	**SD**
AM	1	1	2	5	**2.3**	**1.9**
AQ	4.3	5	3	3.5	**4.0**	**0.9**
DR	4.3	3.3	4	3.5	**3.8**	**0.5**
OR	3	1.5	3.5	6	**3.5**	**1.9**
SH	3.1	2	1	4.5	**2.7**	**1.5**
AZ	3.3	1.5	1.5	3.5	**2.5**	**1.1**
AL	1	2.5	3.3	3.8	**2.7**	**1.2**
NZ	3.3	2.5	4.5	3	**3.3**	**0.8**
JZ	3.3	3	4.3	3.5	**3.5**	**0.6**
MN	4.8	4	4.8	5	**4.7**	**0.4**
Mean (SD)	**3.1**	**2.6**	**3.2**	**4.1**		
SD	**1.3**	**1.2**	**1.3**	**0.9**		
			PM_{10}			
Site						
AM	0.8	0.8	1	3	**1.4**	**1.1**
AQ	3	2	2	1.3	**2.1**	**0.7**
DR	2	1.8	2	3.3	**2.3**	**0.7**
OR	1	1	2.5	6	**2.6**	**2.4**
SH	2	1.5	1	2.3	**1.7**	**0.6**
AZ	1.8	1	3.2	2.4	**2.1**	**0.9**
AL	1	1.5	5.3	2	**2.5**	**1.9**
NZ	1.5	1.4	5	3	**2.7**	**1.7**
JZ	2.8	2	4	2.8	**2.9**	**0.8**
MN	5.4	3.5	4.5	7	**5.1**	**1.5**
Mean (SD)	**2.1**	**1.7**	**3.1**	**3.3**		
SD	**1.4**	**0.8**	**1.6**	**1.8**		

[a] AQL = 1 = good, 2 = moderate, 3 = unhealthy for sensitive group, 4 = unhealthy, 5 = very unhealthy, 6 = hazardous, 7 = very hazardous.

Table 4. Concentrations of major and trace elements and their enrichment factors in $PM_{2.5}$ and PM_{10} from various sites of Riyadh.

	$PM_{2.5}$											
	ng m^{-3}											
Jun2006												
	OR	**AL**	**DR**	**AQ**	**SH**	**JZ**	**NZ**	**AZ**	**MN**	**AM**	**EF (mean)**	**EF (SD)**
Na	ND	0.0	ND	ND	546.9	700.0	0.0	393.8	ND	0.0	0.63	0.29
Mg	ND	1724.2	ND	ND	1174.7	2479.4	1838.6	2472.2	ND	418.9	2.1	0.44
Al	ND	2340.0	ND	ND	1901.2	3653.2	2274.4	3218.4	ND	752.2	1.0	
Si	ND	6618.3	ND	ND	5044.1	9727.0	7791.1	9076.4	ND	2216.1	0.86	0.05
P	ND	37.2	ND	ND	31.3	61.3	49.2	51.4	ND	13.6	1.19	0.25
S	ND	1437.5	ND	ND	964.1	2608.3	1553.2	1850.9	ND	196.0	96.4	32.5
K	ND	32.4	ND	ND	11.8	47.5	18.8	38.0	ND	0.0	0.05	0.02
Ca	ND	514.5	ND	ND	330.4	783.2	629.9	844.9	ND	248.6	0.5	0.26
Mn	ND	1.5	ND	ND	2.5	2.6	3.2	2.5	ND	1.3	0.09	0.06
Fe	ND	59.8	ND	ND	59.6	79.7	77.3	78.7	ND	30.7	0.03	0.02
Ni	ND	0.4	ND	ND	20.7	25.9	25.5	25.2	ND	14.9	8.82	8.92
Cu	ND	0.2	ND	ND	0.3	0.4	0.4	0.4	ND	0.2	1.14	2.88
Zn	ND	0.1	ND	ND	1.5	2.2	0.4	0.3	ND	0.1	0.17	0.19
Ba	ND	10.3	ND	ND	6.0	4.3	5.9	9.2	ND	6.4	0.6	0.25
Total		**12776.3**			**10095.1**	**20174.9**	**14268.1**	**18062.3**		**974.8**		
Nov2006												
Na	ND	ND	0.0	952.0	0.0	274.3	0.0	0.0	898.6	ND	1.03	0.49
Mg	ND	ND	1862.4	5585.1	0.0	512.0	203.3	240.9	1824.6	ND	2.15	0.36
Al	96.4	ND	3000.5	8327.7	152.8	790.4	296.7	392.8	2742.0	ND	1.0	
Si	286.1	ND	7685.2	22034.3	527.7	2110.4	647.7	1013.3	7810.1	ND	0.86	0.04
P	3.6	ND	45.2	112.2	8.8	25.0	5.6	8.8	55.1	ND	1.52	0.4
S	203.7	ND	2016.2	4148.0	222.7	1417.0	1643.3	513.9	2937.7	ND	278.8	202.9
K	0.0	ND	32.6	105.2	0.0	7.8	0.0	5.4	0.0	ND	0.05	0.02
Ca	66.7	ND	655.6	1773.2	115.6	318.2	55.3	103.8	1888.4	ND	0.78	0.45
Mn	0.7	ND	2.5	6.7	0.9	1.8	1.5	0.5	2.8	ND	0.11	0.05
Fe	14.4	ND	68.5	169.3	25.2	41.3	27.8	15.9	94.7	ND	0.05	0.02
Ni	7.7	ND	27.7	56.2	12.2	18.7	16.5	7.6	37.1	ND	14.1	8.86

Cu	0.1	ND	0.5	0.6	0.2	0.3	0.1	0.1	0.5	ND	0.27	0.17
Zn	0.1	ND	0.3	0.7	0.1	1.4	0.1	0.2	0.5	ND	0.38	0.4
Ba	3.7	ND	4.1	31.5	1.5	7.7	6.9	2.7	11.3	ND	1.31	0.91
Total	**683.0**		**13538.6**	**36765.7**	**1067.8**	**5526.2**	**2904.7**	**2305.9**	**18303.5**	**0.0**		
Feb2007												
Na	723.8	ND	468.1	229.2	ND	ND	1322.2	0.0	ND	164.4	0.63	0.45
Mg	3051.4	ND	1727.7	565.3	ND	ND	1226.7	413.9	ND	448.4	2.06	0.34
Al	3977.1	ND	2848.2	856.2	ND	ND	1741.4	551.9	ND	701.3	1.0	
Si	11682.5	ND	7411.3	2462.5	ND	ND	4800.0	1475.6	ND	2027.6	0.88	0.04
P	54.2	ND	45.5	16.2	ND	ND	24.4	7.9	ND	11.4	1.32	0.23
S	2364.4	ND	2462.4	1159.7	ND	ND	317.8	866.1	ND	166.7	137.8	81.51
K	59.7	ND	34.0	3.1	ND	ND	27.6	3.3	ND	2.0	0.07	0.03
Ca	883.2	ND	747.8	256.0	ND	ND	239.8	70.4	ND	154.1	0.62	0.19
Mn	3.6	ND	3.3	1.7	ND	ND	0.9	0.6	ND	1.1	0.1	0.09
Fe	91.8	ND	87.9	37.7	ND	ND	33.1	17.6	ND	26.3	0.05	0.02
Ni	32.5	ND	37.7	18.3	ND	ND	6.4	7.5	ND	11.7	10.4	10.4
Cu	0.5	ND	0.3	0.2	ND	ND	0.1	0.1	ND	0.2	0.18	0.16
Zn	0.4	ND	0.4	0.3	ND	ND	0.2	0.1	ND	0.2	0.2	0.16
Ba	14.9	ND	12.6	4.7	ND	ND	2.8	2.9	ND	3.7	1.18	1.28
Total	**22940.0**		**15887.3**	**5611.1**			**9743.3**	**3417.8**		**3719.0**		
May2007												
Na	ND	ND	ND	ND	1313.7	824.9	ND	442.7	ND	ND	0.52	0.11
Mg	ND	ND	ND	ND	2821.6	2921.8	2622.9	2779.0	ND	192.5	2.02	0.65
Al	ND	171.1	ND	ND	4566.7	4305.0	3244.6	3617.9	ND	345.7	1.0	
Si	ND	476.8	ND	ND	12115.7	11462.4	11114.3	10202.8	ND	1018.5	0.8	0.19
P	ND	4.1	ND	ND	75.1	72.2	70.1	57.8	ND	6.3	1.07	0.24
S	ND	57.7	ND	ND	2315.7	3073.6	2215.7	2080.6	ND	90.1	91	39.7
K	ND	2.1	ND	ND	28.2	55.9	26.9	42.7	ND	0.0	0.05	0.02
Ca	ND	51.7	ND	ND	793.5	922.9	898.6	949.8	ND	114.2	0.45	0.28
Mn	ND	2.1	ND	ND	6.0	3.0	4.6	2.8	ND	0.6	0.08	0.05
Fe	ND	51.7	ND	ND	143.2	94.0	110.3	88.4	ND	14.1	0.03	0.01
Ni	ND	33.0	ND	ND	49.8	30.5	36.3	28.3	ND	6.9	6.99	6.28

Cu	ND	0.4	ND	ND	0.7	0.5	0.6	0.5	ND	0.1	1.11	2.89
Zn	ND	0.2	ND	ND	3.5	2.6	0.6	0.4	ND	0.0	0.16	0.2
Ba	ND	15.5	ND	ND	14.5	5.1	8.4	10.3	ND	3.0	0.53	0.25
Total		**866.5**			**24248.0**	**23774.5**	**20353.9**	**20304.0**		**1791.9**		

PM_{10}

ng m^{-3}

	OR	**AL**	**DR**	**AQ**	**SH**	**JZ**	**NZ**	**AZ**	**MN**	**AM**	**EF (mean)**	**EF (SD)**
Jun2006												
Na	ND	312.1	ND	2978.7	936.2	1020.3	798.9	772.2	4399.4	344.4	0.73	0.3
Mg	1724.2	2370.2	ND	19758.9	3215.6	4333.9	3490.3	3440.5	31259.9	360.0	2.06	0.31
Al	2340.0	3261.0	ND	22431.2	4879.4	6944.9	4902.4	4551.9	38126.9	971.7	1.0	
Si	6618.3	9058.2	ND	68397.2	13539.0	19051.6	14064.7	13670.9	94205.3	2675.6	0.88	0.09
P	37.2	49.2	ND	257.3	77.2	116.4	91.4	75.8	445.2	21.9	1.39	0.24
S	1437.5	880.6	ND	4147.5	1968.8	3434.2	2242.5	2075.9	15484.1	259.7	125.1	44.7
K	32.4	19.4	ND	439.1	67.1	54.5	71.8	51.4	164.0	0.0	0.05	0.01
Ca	514.5	493.2	ND	5225.5	1075.6	1714.8	1459.4	1373.4	24646.4	218.2	0.46	0.1
Mn	1.5	3.5	ND	12.8	13.2	7.0	3.4	3.9	16.5	2.3	0.24	0.37
Fe	59.8	98.8	ND	445.7	4.4	206.6	108.0	125.9	561.4	59.1	0.1	0.15
Ni	0.4	35.7	ND	62.2	124.8	59.5	28.1	32.7	107.9	30.0	9.54	4.25
Cu	0.2	0.7	ND	1.3	35.3	1.3	0.5	0.6	2.1	0.3	0.61	0.98
Zn	0.1	0.3	ND	0.8	0.4	4.3	0.6	0.5	4.1	0.2	0.52	0.43
Ba	10.3	8.1	ND	0.0	14.3	0.0	8.0	15.7	42.6	3.8	0.78	0.6
Total	**12776.3**	**16591.0**	**0.0**	**124158.2**	**25951.3**	**36949.4**	**27270.0**	**26191.4**	**209465.9**	**4947.1**		
Nov2006												
Na	226.7	ND	534.8	3851.9	463.8	804.5	0.0	177.8	3698.6	125.9	0.96	0.47
Mg	552.2	ND	3083.5	12755.6	2122.9	2127.3	978.0	370.8	8302.6	129.0	1.95	0.09
Al	635.4	ND	4852.2	18766.7	2657.4	2989.0	1075.3	640.0	11669.6	229.4	1.0	
Si	1804.6	ND	13291.3	51222.2	7525.8	8470.5	2982.7	1674.3	35295.7	671.0	0.84	0.11
P	13.9	ND	69.4	258.9	49.2	80.8	21.1	19.0	196.7	5.3	1.99	1.09
S	1011.1	ND	2276.1	6496.3	2029.0	3402.1	3303.4	892.7	8446.1	178.9	441	391
K	3.4	ND	70.2	284.4	37.9	29.5	0.0	4.4	61.5	0.0	0.05	0.01
Ca	202.1	ND	1565.2	5766.7	768.3	1633.8	341.7	262.3	12492.2	83.2	0.76	0.44
Mn	1.0	ND	4.0	12.6	3.2	4.3	2.3	1.4	9.6	0.5	0.24	0.2

Fe	30.2	ND	105.1	395.6	78.3	122.1	53.0	34.3	311.5	14.5	0.1	0.08
Ni	14.7	ND	32.0	89.3	30.2	40.4	27.1	16.6	77.3	7.9	30.2	26.1
Cu	0.2	ND	0.5	1.4	0.4	1.4	0.4	0.2	1.1	0.0	0.55	0.47
Zn	0.1	ND	0.6	1.5	0.4	3.7	0.2	0.3	1.1	0.1	0.63	0.59
Ba	5.7	ND	10.0	51.1	9.2	11.6	8.9	5.2	31.2	3.4	2.58	2.67
Total	**4501.2**		**25894.9**	**99954.1**	**15775.9**	**19720.9**	**8794.1**	**4099.3**	**80594.7**	**1449.2**		
Feb2007												
Na	ND	6178.7	1166.7	888.9	0.0	ND	5041.7	879.4	4011.3	0.0	0.7	0.1
Mg	ND	24574.5	3573.6	1605.6	619.4	ND	1925.0	947.8	29993.8	222.6	2.07	0.19
Al	ND	38921.3	5604.2	2393.1	747.7	ND	2786.1	1229.2	41344.7	474.7	1.0	
Si	ND	110280.9	14902.8	6929.2	2209.3	ND	7894.5	3511.1	127648.2	1418.9	0.85	0.04
P	ND	539.7	79.3	42.4	16.1	ND	43.8	21.9	651.3	10.7	1.15	0.14
S	ND	3504.6	2912.5	1881.9	748.2	ND	459.7	1074.7	7061.6	206.5	195.4	139.9
K	ND	737.7	81.1	9.7	8.0	ND	57.1	19.9	1065.6	0.0	0.04	0.03
Ca	ND	6066.4	2066.7	1033.8	311.8	ND	615.3	289.4	11601.1	234.4	0.38	0.12
Mn	ND	20.8	4.3	3.7	1.1	ND	1.2	1.1	23.2	1.7	0.09	0.04
Fe	ND	766.3	120.3	88.5	35.3	ND	54.3	28.8	1031.8	31.8	0.04	0.01
Ni	ND	104.7	34.4	35.8	15.2	ND	6.0	6.8	83.0	17.0	10.7	5.22
Cu	ND	1.9	0.4	0.5	0.1	ND	0.2	0.1	1.5	0.2	0.21	0.1
Zn	ND	1.1	0.4	0.7	0.1	ND	0.3	0.1	4.1	0.2	0.19	0.1
Ba	ND	38.9	23.2	12.9	6.3	ND	1.4	2.7	40.1	8.1	0.91	0.31
Total		**191737.3**	**30569.8**	**14926.7**	**4718.6**	**0.0**	**18886.5**	**8013.0**	**224561.4**	**2626.9**		
May2007												
Na	0.0	645.3	ND	1531.3	1845.2	998.6	1775.0	1186.7	549.4	80.9	0.73	0.3
Mg	11348.9	4901.6	ND	10157.3	6337.8	4241.7	7755.0	5287.5	3904.0	84.5	2.06	0.31
Al	15402.5	6743.7	ND	11531.0	9617.2	6797.2	10892.5	6995.6	4761.7	228.1	1.0	
Si	43563.7	18732.3	ND	35160.4	26684.9	18646.2	31250.0	21010.1	11765.3	628.2	0.88	0.09
P	244.6	101.8	ND	132.3	152.1	113.9	203.0	116.5	55.6	5.1	1.39	0.24
S	9462.0	1821.0	ND	2132.1	3880.4	3361.1	4982.5	3190.4	1933.8	61.0	125.2	44.72
K	213.4	40.2	ND	225.8	132.2	53.3	159.5	79.0	20.5	0.0	0.05	0.01
Ca	3386.6	1019.9	ND	2686.3	2120.0	1678.3	3242.5	2110.7	3078.1	51.2	0.46	0.1
Mn	9.8	7.3	ND	6.6	26.0	6.9	7.6	6.1	2.1	0.5	0.24	0.37

Fe	393.7	204.2	ND	229.1	8.7	202.2	240.0	193.6	70.1	13.9	0.1	0.15
Ni	2.4	73.9	ND	32.0	246.0	58.3	62.5	50.2	13.5	7.0	34.9	62.1
Cu	1.5	1.4	ND	0.7	69.5	1.3	1.2	0.9	0.3	0.1	0.61	0.98
Zn	0.6	0.6	ND	0.4	0.8	4.2	1.4	0.8	0.5	0.0	0.52	0.43
Ba	67.5	16.7	ND	0.0	28.2	0.0	17.8	24.1	5.3	0.9	3.87	7.59
Total	**84097.2**	**34310.1**	**0.0**	**63825.1**	**51149.2**	**36163.2**	**60590.5**	**40252.3**	**26160.1**	**1161.5**		

ND = not determined