

**AN OVERALL MODEL FOR AIR QUALITY MONITORING
WITHIN TURKEY FOR IMPLEMENTATION OF
EUROPEAN AIR QUALITY FRAMEWORK, DAUGHTERS
AND RELATED DIRECTIVES**

Bülent Atamer

Terralab, 06460 Ankara, Turkey, bulent-atamer@terralab.com.tr

ABSTRACT

The objective of this paper is to provide a model to establish the basis for an overall model for air quality monitoring within Turkey for implementation of Air Quality Framework, first, second and third Daughter Directive, as well as the EoI Directives.

Current situation in air quality monitoring in Turkey is discussed.

It is concluded that Turkey stands at the starting point for preliminary assessment.

The network for preliminary assessment under the provincial structure of the MoEF implies every province to be taken as a zone in monitoring air quality. This assumption is not critical, because assignment of zones have no effect on the number of sampling points. However the zone concept is very important from manageability point of view.

The assumptions that need to be made for setting up a national air quality monitoring network are discussed.

Number of sampling points for comprehensive air quality monitoring is calculated to be slightly more than 200 sites.

Key Words: air quality monitoring, air quality

INTRODUCTION

Followings are the directives under consideration:

Air Quality Framework Directive (Council Directive 96/62/EC of 27 September 1996 on ambient air quality assessment and management)

First Daughter Directive (Council Directive 1999/30/EC of 22 April 1999 relating to Limit Values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air)

Second Daughter Directive (Council Directive 2000/69/EC of 16 November 2000 relating to limit values for benzene and carbon monoxide in ambient air)

Third Daughter Directive (Council Directive 2002/3/EC of 12 February 2002 relating to ozone in ambient air).

The related Directives, are:

First EoI Directive (Council Directive 97/101/EC of 27 January 1997 establishing a reciprocal exchange of information and data from networks and individual stations measuring ambient air pollution)

Amendment of EoI Directive (Council Directive 2001/752/EC of 17 October 2001 amending Annexes of EoI Directive to adopt the list of pollutants covered to changes and requirements on additional information, validation and aggregation.

ASSUMPTIONS

- The monitoring system establishment related scenarios are based on the assumption that transposing EU directives to Turkish legislation is completed and enforced during the next years, up till the year 2010. It is assumed further that efficient enforcement of strict air quality management legislation will encourage private sector to assume responsibility for compliance with the requirements.
- Deadlines and limit values set in the AQF and daughter directives have been taken into account.
- Even though some measurements are taken by various stations in Turkey, the data quality, technical compliance with the reference methods, sampling point compliance are highly questionable and the parameters do not fall into the ones required. Therefore it is safe to assume that Turkey stands at the starting point for preliminary assessment.
- MoEF is responsible for setting limits and thresholds, performing measurements and doing assessment. The network for preliminary assessment under the provincial structure of the MoEF implies every province to be taken as a zone in monitoring air quality. This assumption is not critical, because assignment of zones have no effect on the number of sampling points. However, the zone concept is very important from manageability point of view. Even if the structure of the competent authority changes in the future, this will have no effect on the estimation, made herewith.
- Stations for preliminary assessment should be placed and designed in such a way that they can be used for continuous monitoring after completion of the preliminary assessment period.

- Based on the comments in the Guidance on Assessment under the EU Air Quality Directives, and the Annexes in the Air Framework Daughter directives the minimum number of sampling points for fixed measurement of pollutant concentrations is assigned as shown in Annex 9.
- In Annex 9 are shown the minimum number of sampling points in cases where the Upper Assessment Threshold (UAT) is exceeded or in cases where pollutants concentrations are below the Lower Assessment Threshold (LAT). Number of sampling points are assigned on the basis of pollutant concentrations exceeding the upper assessment threshold (UAT), set by the directive 99/30/EC.
- Urban areas having a population more than 250 000 are assumed to be an agglomeration.
- One sampling point is assigned per 20 000km² in the rural areas.
- Additionally, rural areas holding a population density more than 260 people per square kilometre (based on the fact that, average urban population density in the provinces, where population is more than 250 000 inhabitants, is 260 persons per square kilometre) are also assumed to be agglomerations.
- Some of the provinces have high industrial activity, therefore are assumed as Industrial Hot Spots for monitoring.
- Some of the provinces have heavy traffic load because of their transit position on high ways, therefore traffic hot spots are assumed for monitoring.

Comment [cwn1]: It seems to me that we should have used this interval in calculation of the number of sampling points and hence in the cost calculation - maybe Bülent can do this?

These assumptions allow us to be on the safe side in terms of considering all the densely populated parts of the country.

Different compound coverage is assumed for stations situated at sites with different characteristics (population, traffic, industrial, rural).

The features of a typical monitoring station, applicable for all kind of stations are suggested to be as follows:

generate data on levels of pollutant concentration in ambient air (SO₂, NO₂, PM₁₀, PM_{2.5}, Pb, O₃, Benzene, CO, PAHs, Cd, As, Ni, Hg, 30 VOCs and nm-HC) by means of either continuous measurement at fixed sampling points or periodic measurement techniques based on sample collection followed by analysis in a laboratory / modelling / objective estimation techniques,

generate data for SO₂ , NO₂ and NO_x and O₃ on hourly basis, for CO on 8-hourly basis, for PM₁₀ and likely for PM_{2.5} on 24-hourly basis, for Pb and Benzene on annual basis, at the sampling points where continuous measurement is imposed,

comply with requirements on the number of sampling points for fixed measurements in zones and agglomerations,

comply with zoning and agglomerations criteria,

The legal minimum number of stations is chosen as the basis for cost calculation, based on the comments in the EC Guidance on Assessment document (EC, 2003).

CONCLUSIONS

Explanation on how and where all monitoring stations for preliminary assessment are proposed is presented in the Table 3.

Comment [D2]: There is no detailed explanation there. It is not enough to have just table. I think some little text must be put here how we arrived at this number of stations.

Population data are obtained from SIS. Total, urban and rural population figures are given in Table 3.

Province areas are obtained from the web site of the Ministry of Interior. Total province areas add up to 549292 square km.

Urban population is assumed to stay in 30% of the province area, therefore rural population is assumed to stay in the remaining 70% of the province area.

Rural population density is calculated by dividing the rural population by the rural area. This figure came out to be 260 people per square km.

Urban areas, where the population density is greater than the average rural population density, are assigned as population agglomerations. Three sites came out to be urban population sites as dense as average rural character.

Total rural area of Turkey is assumed to be 80% of the total area of Turkey, and calculated to be 610027 square km.

Average urban population density is calculated by dividing total urban population by 30% of the total province area.

Sampling points in the urban agglomerations are calculated alternatively, on the basis of pollutant concentrations to be higher than the upper assessment threshold (UAT) and lower than the lower assessment threshold (LAT). The total number of sampling points are given on the assumption that the pollutant concentrations will be higher than UAT.

Total area of Turkey is given to be 774815 square km in the web site of Ministry of Interior

It should be noted that there is only a macro planning for preliminary assessment of air quality management requirements. There is a need for further study on micro siting of monitoring stations as well as specifying the pollutants to be monitored at each station.

Setting up quality assurance system is another significant component to be handled separately.

The next steps after preliminary assessment should be identifying the points of continuous sampling and areas, where air quality to be objectively estimated.

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TABLE 1: Number of stations per pollutant and station type in Europe 2002

	Daughter Directive							
	1	1	1	1	1	2	2	3
	Sulphur dioxide	Nitrogen dioxide	Particulate matter (<10 µm)	Particulate matter (<2.5 µm)	Lead	Carbon monoxide	Benzene	Ozone
Reporting EU countries	14	14	14	5	4	13	8	14
Total number of stations	1678	1815	1164	37	85	834	179	1524
<i>Of which</i>								
Traffic	394	527	363	8	49	419	97	312
Urban background	598	679	457	20	16	303	58	610
Industrial	333	233	140	0	11	48	7	129
Regional background	256	263	127	1	6	35	7	342
Other 1)	98	113	77	8	3	29	10	131
Reporting non-EU countries	15	14	11	2	2	9	2	13
Total number of stations	249	231	142	5	27	80	5	147
<i>Of which</i>								
Traffic	35	35	26	2		20	2	20
Urban background	151	136	82	2	23	44	2	60
Industrial	15	12	7	1	3	6	0	9
Regional background	48	48	27	0	1	10	1	58
Other 1)	0	0	0	0	0	0	0	
All countries	29	28	25	7	6	22	10	27
Total number of stations	1927	2046	1306	42	112	914	184	1671

1) Primarily unknown.

Source: page 12 of 52 ETC/ACC Technical paper 2004/1, Table 3 (10)

TABLE 2: Number of stations in the EU and other countries

	SO ₂		NO ₂		PM ₁₀		PM _{2.5}		Pb	CO	Benzene		O ₃
EoI Code	1		2		3		4		6	9	8		7
Time Resolution	H	D	H	D	H	D	H	D	D	H	H	D	H
Austria	138		144			74	1			47			113
Albania 4)													
Belgium	67		47			23	3		28	18		5	33
Bosnia Herzegovina	1		1							1			
Denmark	2	2	12			8				6	1		8
Bulgaria	38		38			7			19				
Finland	9	4	4		26		3			4			12
Cyprus 4) . .													
France	477		491			269	28			103			399
Czech Republic	55		55		53					27	4		35
Germany	417		476		264	116				297	77		377
Estonia	7		7			4				5			7
Greece	23		26		15					15			26
FYROM		25											
Ireland	6		6			8					1		7
Hungary	1	1	1	1	1					1			2
Italy	94		117		46	4				84	32		99
Iceland	1		2		2		2			1	1		3
Luxembourg 4)													
Latvia	6	2	6	2		1							6
Netherlands	38	45		20					4	22		4	38
Liechtenstein 4)													
Portugal	30		32		21	1	2		1	26			26
Lithuania		1		1									3
Spain	22	10	272		140	55			52	130	18		299

	SO ₂		NO ₂		PM ₁₀		PM _{2.5}		Pb	CO	Benzene		O ₃
EoI Code	1		2		3		4		6	9	8		7
Malta													1
Sweden	4	5	7	14	4					3			8
Norway	1	7	1	6	3								10
United Kingdom	79		102		65	5				79	6	35	79
Poland	17	31	28	20		33	3			24			21
Romania 2		23		18					8				2
Slovak Republic	8		8		8					5			17
Slovenia	8		6		7					4			10
Switzerland 31	16		30			23				12			30
Turkey 4) . .													
TOTAL	159	90	183	48	74	68	5	0	27	80	5		147

Source: ETC/ACC Technical paper 2004/1 page 19 of 52 (10)
Table 4-5 Number of stations in the EU countries for which data for components of the daughter directives were available in AirBase, 2002

TABLE 3: Identification of Monitoring Stations for Turkey

Provinces	Population				Province area	Agglomeration Sampling Points		Additional Sampling Points		
	Total	Urban	Rural	Rural pop. density		Total if <LAT	Total if >UAT	For Dense Pop.	For Hot Spots	
								RPD>260	Industrial	Traffic
Adana	1 849 478	1 397 853	451 625	46	14 030	2	4		2	1
Adıyaman	623 811	338 939	284 872	53	7 614	1	2			
Afyon	812 416	371 868	440 548	44	14 230	1	2			1
Ağrı	528 744	252 309	276 435	35	11 376	1	2			
Amasya	365 231	196 621	168 610	44	5520					
Ankara	4 007 860	3 540 522	467 338	26	25 706	2	7		2	1
Antalya	1 719 751	936 330	783 421	54	20 591	1	3			1
Artvin	191 934	84 198	107 736	21	7436					
Aydın	950 757	493 114	457 643	82	8 007	1	2		2	1
Balıkesir	1 076 347	577 595	498 752	50	14 292	1	2			1
Bilecik	194 326	124 380	69 946	23	4307				2	
Bingöl	253 739	123 470	130 269	23	8125					
Bitlis	388 678	219 511	169 167	36	6707					
Bolu	270 654	142 685	127 969	25	7410				1	1
Burdur	256 803	139 897	116 906	24	6887					
Bursa	2 125 140	1 630 940	494 200	64	11 043	1	5		2	1
Çanakkale	464 975	215 571	249 404	37	9737				1	
Çankırı	270 355	141 186	129 169	25	7388					
Çorum	597 065	311 897	285 168	32	12 820	1	2			

Comment [D3]: What does it mean LAT and UAT; also RPD

Provinces	Population				Province area	Agglomeration Sampling Points		Additional Sampling Points		
	Total	Urban	Rural	Rural pop. density		Total if <LAT	Total if >UAT	For Dense Pop.	For Hot Spots	
								RPD>260	Industrial	Traffic
Denizli	850 029	413 914	436 115	52	11 868	1	2		2	
Diyarbakır	1 362 708	817 692	545 016	51	15 355	1	3			
Edirne	402 606	230 908	171 698	39	6279					
Elazığ	569 616	364 274	205 342	32	9 153	1	2			
Erzincan	316 841	172 206	144 635	17	11903					
Erzurum	937 389	560 551	376 838	21	25 066	1	2			
Eskişehir	706 009	557 028	148 981	16	13 652	1	2		1	
Gaziantep	1 285 249	1 009 126	276 123	66	6 000	1	4		2	1
Giresun	523 819	283 316	240 503	50	6 934	1	2			
Gümüşhane	186 953	77 570	109 383	24	6575					
Hakkari	236 581	139 455	97 126	19	7121					
Hatay	1 253 726	581 341	672 385	178	5 403	1	2			
Isparta	513 681	301 561	212 120	34	8 993	1	2			
İçel	1 651 400	999 220	652 180	59	15 853	1	3		1	
İstanbul	10 018 735	9 085 599	933 136	257	5 196	3	10	1	5	2
İzmir	3 370 866	2 732 669	638 197	76	11 973	2	6		3	
Kars	325 016	142 145	182 871	27	9587					
Kastamonu	375 476	174 020	201 456	22	13108					
Kayseri	1 060 432	732 354	328 078	28	16 917	1	2		1	
Kırklareli	328 461	189 202	139 259	30	6 550				1	
Kırşehir	253 239	147 412	105 827	23	6 570					

Comment [D3]: What does it mean LAT and UAT; also RPD

Provinces	Population				Province area	Agglomeration Sampling Points		Additional Sampling Points		
	Total	Urban	Rural	Rural pop. density		Total if <LAT	Total if >UAT	For Dense Pop.	For Hot Spots	
								RPD>260	Industrial	Traffic
Kocaeli	1 206 085	722 905	483 180	190	3 626	1	2		2	
Konya	2 192 166	1 294 817	897 349	34	38 257	1	4		2	
Kütahya	656 903	318 869	338 034	41	11 889	1	2		1	
Malatya	853 658	499 713	353 945	41	12 313	1	2			
Manisa	1 260 169	714 760	545 409	56	13 810	1	2		1	
K.Maraş	1 002 384	536 007	466 377	47	14 327	1	2			
Mardin	705 098	391 249	313 849	50	8 891	1	2			
Muğla	715 328	268 341	446 987	48	13 338	1	2		1	
Muş	453 654	159 503	294 151	51	8 196					
Nevşehir	309 914	136 523	173 391	45	5 467					
Niğde	348 081	126 812	221 269	43	7 312					
Ordu	887 765	416 631	471 134	112	6 001	1	2			
Rize	365 938	205 245	160 693	59	3 920					
Sakarya	756 168	459 824	296 344	88	4 817	1	2		1	
Samsun	1 209 137	635 254	573 883	86	9 579	1	2		1	
Siirt	263 676	153 522	110 154	29	5 406					
Sinop	225 574	101 285	124 289	30	5 862					
Sivas	755 091	421 804	333 287	17	28 488	1	2			
Tekirdağ	623 591	395 377	228 214	52	6 218	1	2			
Tokat	828 027	401 762	426 265	61	9 959	1	2			
Trabzon	975 137	478 954	496 183	106	6 685	1	2			1
Tunceli	93 584	54 476	39 108	7	7 774					

Comment [D3]: What does it mean LAT and UAT; also RPD

Provinces	Population				Province area	Agglomeration Sampling Points		Additional Sampling Points		
	Total	Urban	Rural	Rural pop. density		Total if <LAT	Total if >UAT	For Dense Pop.	For Hot Spots	
								RPD>260	Industrial	Traffic
Şanlıurfa	1 443 422	842 129	601 293	46	18 584	1	3			
Uşak	322 313	182 040	140 273	38	5 341					
Van	877 524	446 976	430 548	32	19 069	1	2			
Yozgat	682 919	315 156	367 763	37	14 123	1	2			
Zonguldak	615 599	250 282	365 317	118	4 420	1	2			
Aksaray	396 084	200 216	195 868	37	7 626					
Bayburt	97 358	41 356	56 002	22	3 652					
Karaman	243 210	139 912	103 298	16	9 163					
Kırıkkale	383 508	285 294	98 214	32	4 365	1	2		1	
Batman	456 734	304 166	152 568	46	4 694	1	2			
Şırnak	353 197	211 328	141 869	28	7 172					
Bartın	184 178	48 002	136 176	92	2 120					
Ardahan	133 756	39 725	94 031	24	5 661					
İğdır	168 634	81 582	87 052	35	3 593					
Yalova	168 593	98 661	69 932	471	212			2	1	
Karabük	225 102	157 756	67 346	40	2 420				1	
Kilis	114 724	74 985	39 739	35	1 642					
Osmaniye	458 782	311 994	146 788	56	3 767	1	2			
Düzce	314 266	130 632	183 634	72	3 641					

Comment [D3]: What does it mean LAT and UAT; also RPD