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AIR POLLUTION CONTRIBUTION OF SOME CEMENT PLANTS IN TURKEY

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Abstract

EPA approved BREEZE AIR ISCLT3 software was applied to six existing cement production plants and to a planned cement grinding and mixing plant in two different locations in Turkey for air quality modelling. NO_2 contribution of the six existing plants, NO contribution of three plants, CO contribution of one plant and PM10 contribution of three plants along with particulate matter deposition have been modelled. The PM10 and particulate matter deposition contribution of the planned cement installation in two different locations applying three different meteorology data have also been evaluated.

Air quality contributions of all the plants are below the AQPR limits. However, background levels of the air quality in these areas are not known. NO_2, PM10, and particulate matter deposition of some of the plants are about 30 - 50 % of the AQPR limit. To decide whether these contributions are low or high, either present air quality of the relevant parameter has to be measured, or contribution of all the other major sources of the same area have to be modelled. It has to be mentioned, however, that all the maximum air quality receptor points lie either within or close to the boundaries of the plant area. It can be said that an area with about 1 km diameter around the plants is mostly affected and any urban settlement beyond this limit will be saved from the adverse effects of the air pollution. The application of different meteorological data for the planned cement plant affected the results seriously but not the plant site selection.

Key words : Air quality, modelling, emission, cement.

INTRODUCTION

Cement production is one of the oldest industries in Turkey which has developed along with the urban growth. The surroundings of some of the oldest plants became urbanised so that people faced immediate contact with the air pollution problem. The bad reputation of this industry in this respect is very difficult to erase despite the immense effort the industry has been exerting in this decade. The Turkish cement industry has voluntarily taken precautions to minimise the adverse effects of the air pollution. In an agreement with the Ministry of Environment they have voluntarily set limits which are lower than the national limits set in the Turkish Air Quality Protection Regulation (AQPR) of 1986 (Table 1). In most of the cases application of efficient control techniques has decreased the dust emissions below these limits considerably.

Table 1. Emission and long term average air quality limits for the Turkish cement industry.

Components	CO [μg/m³]	NO [μg/m³]	NO_2 [μg/m³]	SO_2 [μg/m³]	PM10 [μg/m³]	Particular matter deposition [mg/m²day]
LT Values	10000	200	100	150 * 250 **	150 * 200 **	350 * 450 **

* general ** industrial area

Although emission measurement is laborious because of the great number of sources involved it is carried out routinely. Measurement of the contribution of a particular plant to the air quality is, however, very costly and time-consuming and on the other hand it is not always an easy task if the cement plant is in an industrial area where there are many other sources. Air quality modelling techniques are in general very helpful in this respect provided the model is used properly with reliable input data. AQPR accepts the simplest Gaussian dispersion model to assess the air quality contribution of a plant to be built. Developed models, however, can also be used for the existing plants.

There are many air quality models available to assess the local impacts of routine emissions of nonreactive pollutants on the environment (Table 1, Seigneur, 1992). Of these the Long Term Industrial Source Complex (ISCLT) model is the most flexible and can be applied also in areas of complex terrain where elevation exceeds stack height.

Table 2. Models for impact assessment of routine emissions of nonreactive pollutants.

Model	Number of sources	Meteorological conditions	Terrain	Elevation	Urban or rural
SCREEN	one	worst-case	flat	accepted	-
Industrial Source Complex (ISC)	multiple	actual	flat	accepted	urban or rural
COMPLEX1	multiple	actual	complex	accepted	rural
SHORT Z LONG Z	multiple	actual	complex or flat	accepted	urban or rural
Rough Terrain Dispersion Model (RTDM)	multiple, co-located	actual	complex	accepted	-
Offshore and Coastal Dispersion (OCD)	multiple	actual	coastal	-	-

METHODS

The emissions were determined by the Environment and Quality Control Directorate of the Turkish Cement Producers Association applying EPA methods. For the air quality modelling of the planned cement plant, design data was used.

BREEZE AIR ISCLT3 of Trinity Consultants, Inc. was used to assess the impact of the emissions on the ambient air quality. The software is a Windows based program for the development of the EPA long term industrial source complex (ISCLT3) model. The software is capable of analysing the emissions of up to 1000 point, area, volume, and open pit sources which may be grouped. Receptor grids as well as discrete receptors can be defined to assess the air quality in a particular urban location. Concentrations can be calculated for all terrain elevations up to stack height and for receptors above ground elevation. It requires summary meteorological data in a frequency distribution of wind speed, stability class, and wind direction (star data).

Star data was prepared from the long term monthly average climate data published by the Turkish Meteorology Office. The stability classes have been calculated by considering the rules in AQPR and EPA régulatory options. Topography around the plants was investigated and the relevant file was prepared by reading elevations on a 1/25,000 chart in 250 m distances for a grid of 5 km by 5 km. The elevations and locations of discrete sources for which the air quality has to be calculated specifically is also read on the map. The locations of the emission sources are also indicated in the same grid file.

PLANTS STUDIED

In the modelling studies 7 plants are considered. For the sake of confidentiality the names of the plants are not given in this article and therefore they are designated with numbers. The production capacities of the plants and the numbers of point sources of emissions are given in Table 3. Properties of the locations of the plants are also given in the same table. NO_2 contribution to the ambient air quality of six existing plants, NO contribution of three existing plants, CO contribution of one existing plant, and PM10 contribution of three existing plants along with particulate matter deposition have been investigated. The PM10 and particulate matter deposition contribution of the planned cement installation (plant 7) have also been investigated in two different locations (7a and 7b/c) and for one of the locations by applying two different meteorological data (7b and 7c).

Table 3. Characteristics of the cement plants investigated.

Plant No.	Production capacity	Number of point sources	Rural/ urban	Surface	Elevation
1	1.800.000 t/y clinker	69	urban	flat	low elevation, coastal
2	837.500 t/y clinker	19	rural	complex	medium elevation, approx. 600 m
3	385.000 t/y clinker	17	urban	mostly flat	high elevation, approx. 1000 m
4	1.485.000 t/y clinker	7	urban	flat	low elevation, coastal
5	460.000 t/y clinker	15	urban	flat	medium elevation approx. 850 m
6	1.460.000 t/y clinker	2	urban	flat	low elevation, coastal
7a	600.000 t/y cement	8	rural	complex	medium elevation, approx. 600 m
7b	600.000 t/y cement	8	rural	complex	medium elevation, approx. 600 m
7c	600.000 t/y cement	8	rural	complex	high elevation, approx. 1000 m

RESULTS AND DISCUSSION

The results of modelling studies using BREEZE AIR are shown in Table 4 where the maximum of the annual average values for each receptor point are given for all plants with regard to CO, NO, NO2, PM10, and particulate matter deposition, respectively. A comparison of these values with the AQPR limits are shown in Table 5.

As it is seen from Table 5, air quality contributions of all the plants are below the AQPR limits. However, background levels of the air quality in these areas are not known. NO_2, PM10, and particulate matter deposition of some of the plants are about 30 - 50 % of the AQPR limit. To decide whether these contributions are low or high, either present air quality of the relevant parameter has to be measured, or contribution of all the other major sources of the same area have to be modelled. It has to be mentioned, however, that all the maximum air quality receptor points lie either within or close to the boundaries of the plant area.

Table 4. Maximum of the annual average values of air quality contributions.

Plant No.	CO [μg/m^3]	NO [μg/m^3]	NO_2 [μg/m^3]	PM10 [μg/m^3]	Particular matter deposition [mg/m^{2}day]
1	209	18.0	45.0	6.0	116
2	-	12.0	27.6	7.6	4.8
3	-	6.82	15.7	-	-
4	-	-	43.0	-	-
5	-	-	10.8	21.0	74.7
6	-	-	27.9	-	-
7a	-	-	-	46.7	-
7b	-	-	-	64.6	38.2
7c	-	-	-	18.0	13.9

Table 5. Contributions of plants to ambient air quality with respect to AQPR.

Plant No.	CO %	NO %	NO_2 %	PM10 %	Particular matter deposition, [%]
1	2	9	45	4 *	33 *
				3 **	26 **
2	-	6	28	5 *	2 *
				4 **	1 **
3	-	3	16	-	-
4	-	-	43	-	-
5	-	-	11	14 *	21 *
				11 **	17 **
6	-	-	28	-	-
7a	-	-	-	31 *	-
				23 **	
7b	-	-	-	43 *	11 *
				32 **	9 **
7c	-	-	-	12 *	4 *
				9 **	3 **

* general ** industrial area

Fig. 1 and 2 show the windrose, topography, and PM10 contributions of the no 1 (urban, flat, low elevation) and no 2 (rural, complex, medium elevation) plants, respectively. It can be seen clearly that an area with about 1 km diameter around the plants is mostly affected and any urban settlement beyond this limit will be saved from the adverse effects of the air pollution.

Lack of meteorological data for the planned cement installation (cases 7b and 7c) caused us to use alternatively the data of the two nearest meteorological stations which are about 100 km away, each. The windroses and PM10 contributions of this plant in a rural, complex terrain, and high elevation area are shown in Fig. 3. As it can be seen in Table 4 and 5 and Fig. 3 the results differ by a factor of about 4. This modelling study was done to decide on a plant site with small air pollution contribution. The low results in both cases and the lack of any other industrial installation in the vicinity proved the disagreement to be unimportant.

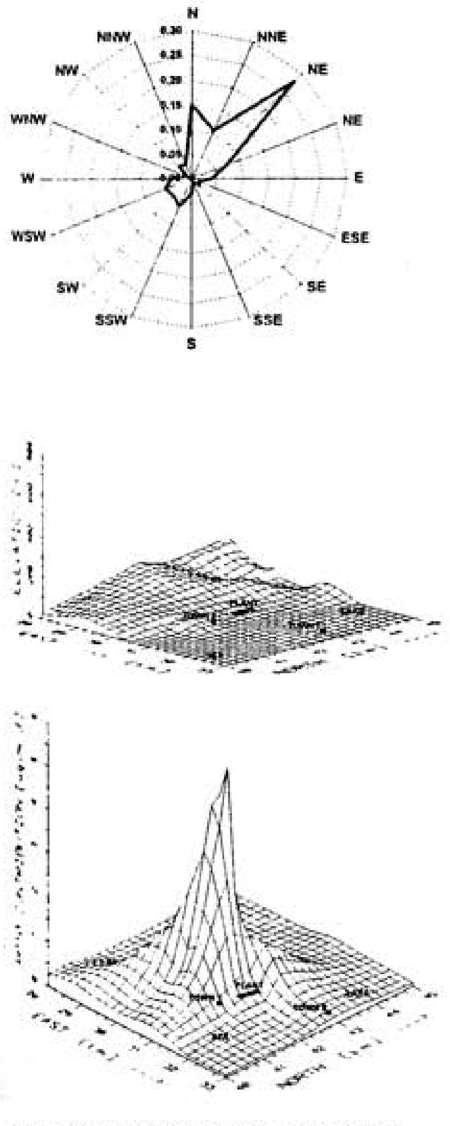

Fig. 1 Windrose, elevation, and PM10 contribution of plant no. 1

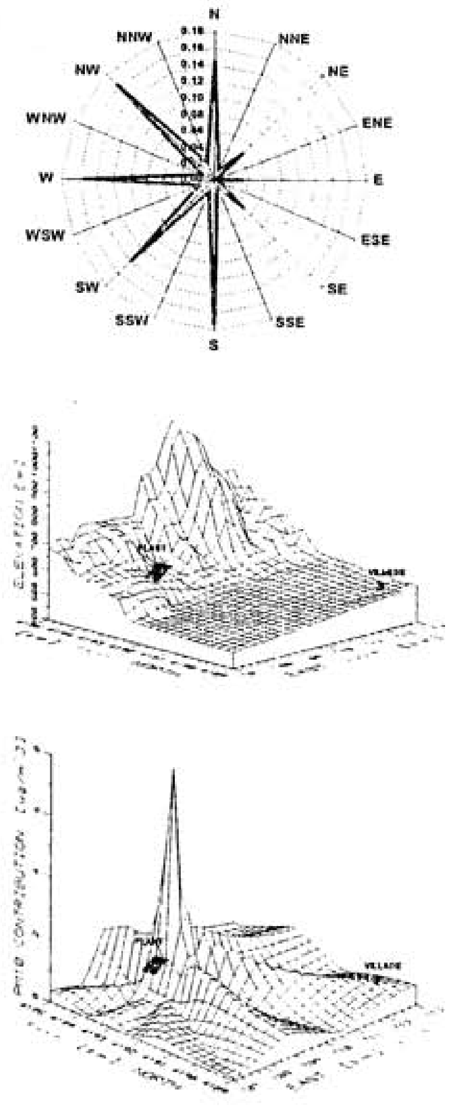

Fig. 2 Windrose, elevation, and PM10 contribution of plant no. 2

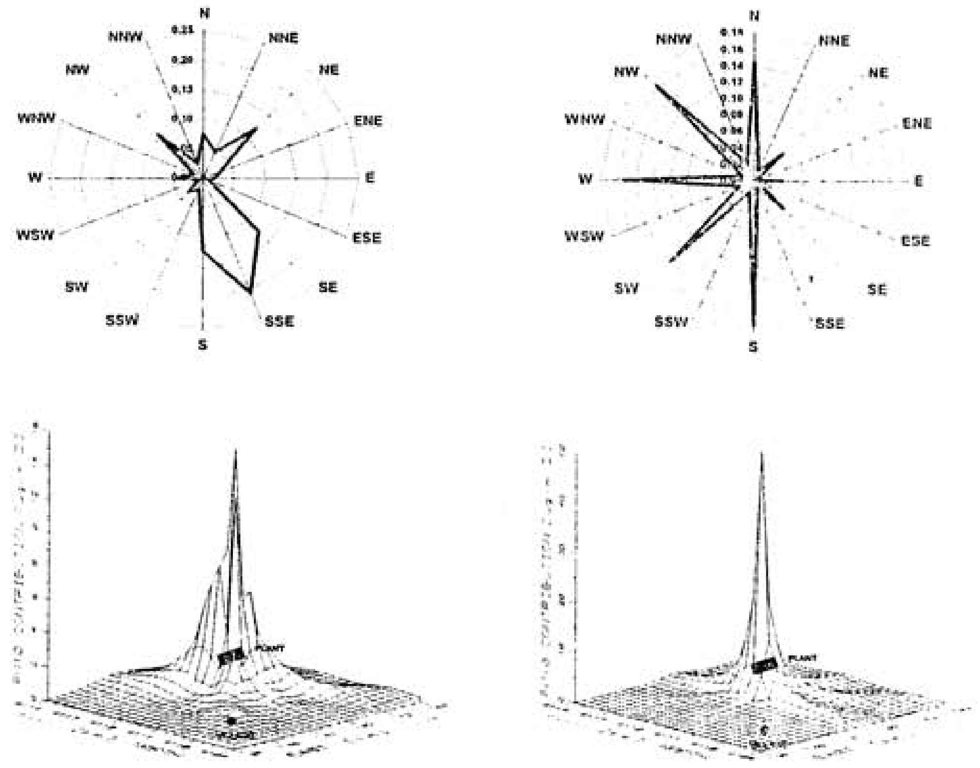

Fig. 3 Windrose and PM10 contribution of plant no. 7 with two different meteorology data.

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