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An analysis of the environmental threats posed by industry in Kocaeli, Turkey

M. Sarper Erdogan, Cavit Yavuz, Cigdem Caglayan, Nilay Etiler and Onur Hamzaoglu

Department of Public Health, Kocaeli University, Derince, Turkey

Abstract

Purpose – This paper has been produced to enumerate and discuss threats which are caused by industry and may affect health in the province of Kocaeli.

Design/methodology/approach – Industries in the province, depending on their function, were grouped into sectors. Air, water and solid waste pollutants produced by each sector were assessed for each region of the province.

Findings – Of the 7,400 industries in the province, only 1,198 are registered with the Kocaeli Chamber of Industry and of this number only a minority are subject to controls by the Ministry of the Environment through the Kocaeli Provincial Directorate of the Environment (KPDE). Data on pollutants were obtained from the KPDE. Liquid waste was controlled in 370 firms (5 per cent) of all industries in the province, air quality in 444 (6 per cent) and dangerous waste in 4 (0.06 per cent). A total of 41 firms were designated as having dangerous pollution profiles.

Practical implications – These figures suggest that industrial development in the province of Kocaeli has not been accompanied by adequate environmental protection. Stricter control for present and future industries is urgently required. Attention must also be directed at zoning industrial and residential areas to safeguard human health and the environment.

Originality/value – Provides information on environmental threats caused by industry in Turkey.

Keywords Environmental health and safety, Turkey, Developing countries

Paper type Research paper

Introduction

Environmental threats have been classified as physical, chemical and biological. Risk in this paper refers to an estimate of the chances of harm to the environment or biota caused by industrial activities as well as the extent of the harm. Risks that can be qualitatively estimated and provide clues about what protective measures should be instituted. In that context, identifying the threat that constitutes the source of the risk is the first step in determining and assessing the health risks to the environment (Hohenemser *et al.*, 1987; Wakefield and Elliot, 2000; Yolsal and Orkun, 1998).

In Turkey the environmental effects of industry are regulated by Environment Law 2872 (Guler and Cobanoglu, 1996). The law includes by-laws protecting air quality (BAQ), control of water pollution (BCWP), control of dangerous wastes (BCDW), control of solid wastes (BCSW), etc. Authority to enforce the act and its by-laws is

We are indebted to the Kocaeli Chamber of Industry for providing a list of the industries in the province of Kocaeli and to the Kocaeli Provincial Directorate of the Environment for providing data on industrial pollutants in the province. We would also like to thank Dr John Martin of Canada for reading and revising this article.

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vested in the Ministry of the Environment at the national level, and at the provincial level in the provincial directorates of the environment such as the Kocaeli Provincial Directorate of the Environment (KPDE).

Kocaeli, in Western Anatolia id about 60 km from Istanbul, it is an industrial province containing 17 per cent of Turkish firms (Figure 1).

Despite being the third smallest city in area (0.45 per cent of Turkey's land mass) in 81 incorporated cities, Kocaeli surprisingly contributes to the country's industrial production with a high rate of 12.8 per cent (Kocaeli Chamber of Industry, 1998). Industrialisation began in the 1960s and accelerated in the following decades.

Kocaeli contains 13 per cent of the manufacturing sector in Turkey, including 2 per cent of consumer goods, 23.6 per cent of intermediary goods and 10.4 per cent of primary goods. The Kocaeli proportion of sectors for Turkey is as follows:

- chemical: 33 per cent;
- machinery: 20 per cent;
- metal: 18 per cent;
- stone-sand: 10 per cent;
- paper: 10 per cent; and
- transportation vehicles: 6 per cent (Kocaeli Provincial Directorate of the Environment, 2000).

This considerable share of the industrial production of Turkey is produced by 7,400 industrial firms.

Among 7,400 firms only 1,198 are registered with the KCI. Those firms whose waste liquid is controlled by the KPDE are 370 (5 per cent of the total number of 7,400 firms); those whose air quality is controlled are 444 (6 per cent); those whose dangerous waste is controlled are 44 (0.06 per cent). The controlled firms have a high polluting effect. But there are possibly many other polluting firms such as the



Figure 1.
Kocaeli, Turkey

chemicals and metals that are not controlled. The lack of inspection of industries participating in industrial sectors with high polluting effects is a matter of concern. We believe the polluting threats emerging from industry in Kocaeli are underestimated. This review aims at identifying threats posed by industry and their impact on the health of Kocaeli.

Materials and methods

Data from the Kocaeli Chamber of Industry (KCI) and KPDE were obtained with the cooperation of these entities and reviewed. The sectoral classification of the industrial firms was made on the basis of the list from KCI. The environmentally polluting elements of each sector have been evaluated as air and water pollutants and the pollutants in form of solid waste. In order to determine the factors, which may pollute the air, we have benefited from the BPAQ; to determine the factors, which may pollute the water, we have benefited from the BCWP. The dangerous and harmful waste derived from the industrial firms in the region is obtained from the data provided by the control team of the Provincial Directorate of Environment.

In order to further classify firms within sectors into sub-groups on the basis of what they produce, we have used the January-May 2002 data of the control team of water pollution, which is responsible for the control of the wastewater of the factories. KPDE controls the industrial organizations according the tables of the BCWP. These tables designate what kind of polluting parameters should be sought in the wastewater of the organization. Then the probable pollutions that may be caused by the firms belonging to those sectors have been evaluated as threats. The parameters that may pollute the air are subject to a more general classification in the BPAQ. In order to determine polluting emissions in Kocaeli specifically, we have found to which group in BPAQ each sector determined by the KCI corresponds. In the same way, the probable polluting emissions have been evaluated as threats. In the data base formed for all the pollutants, the following variables have been used:

- "the region where the industrial establishment is located";
- "the sector in which the factory operates";
- "the polluting parameters which exist in the BCWP table to which the firm belongs"; and
- "the polluting parameters for the BPAQ group to which it belongs".

The polluting parameters were accepted as potential threats to health.

In the study the province of Kocaeli is divided into six regions (Figure 2):

(1) Region 1 (Gebze): the area within the frontiers of the sub-province of Gebze.

(2) Region 2 (Korfez): the region between the sub-province of Derince and the sub-province of Korfez.

(3) Region 3 (Izmit): the area within Izmit frontiers.

(4) Region 4 (Kosekoy): the area east side of Izmit.

(5) Region 5 (Golcuk): the southern part of the Izmit Gulf.

(6) Region 6 (Kandira): the area in the frontiers of Kandira.

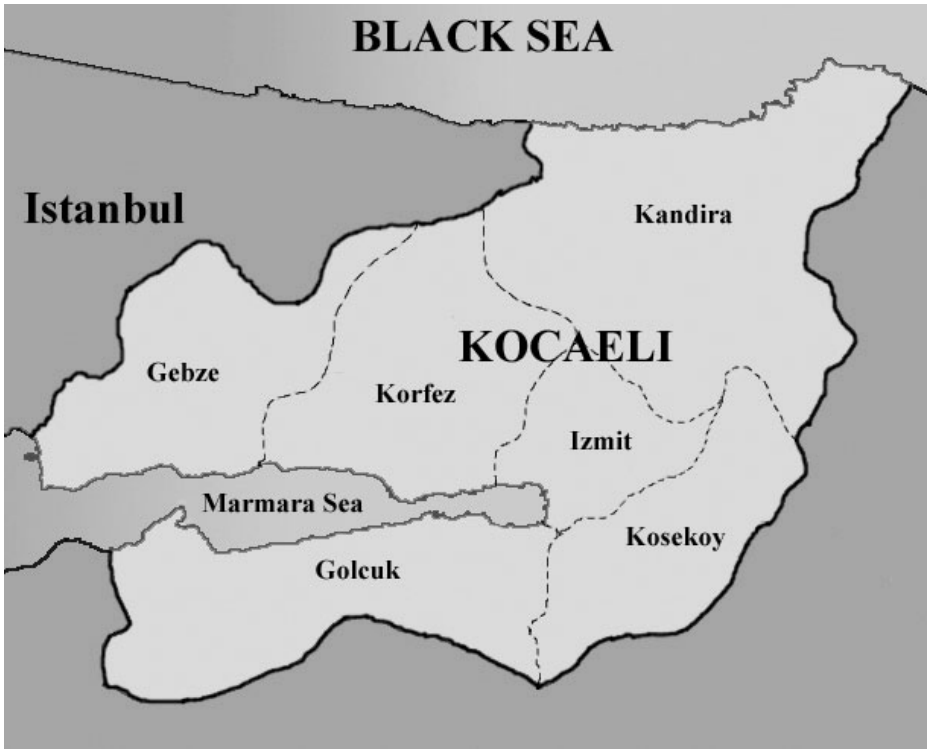


Figure 2.
Regions of Kocaeli

Results

The spatial distribution of industrial firms within the city

A total of 56.9 per cent of the industrial firms are located in region 1; 19.3 per cent in region 3, 7.7 per cent in region 2, 10.9 per cent in region 4, 4.8 per cent in region 5. Only four firms (0.3 per cent) are in region 6 (Table I).

The industrial firms whose liquid wastes are controlled by KPDE

At least 190 factories have a refinery. A total of 20 firms whose polluting effect is very high, pass on their liquid waste to a refinery called The Izmit Joint Stock Company for Refinement and use as waste (IZAYDAS). The method used during refinement is as follows:

- The process is analysed and the source of the wastes in the process is identified.
- The discharge points are identified by inspection of the factory, and at some of these points samples are taken, in accordance with the corresponding by-law.
- The analysis of these samples is performed at the laboratories of the KPDE. The results are evaluated and then reported.
- In case of the violation of a rule, a sanction is imposed.

Table II shows the sectoral distribution of 375 industries whose wastewater disposals were controlled by KPDE.

Sector	Gebze	Korfez	Izmit	Kosekoy	Golcuk	Total
Food industry	19	2	12	5	3	41
Meat – poultry and feed industry	11	1	1	2	4	19
Flour – floured and sugared products industry	9	1	15	2	2	29
Wood products and furniture industry	14	3	14	10	9	50
Paper products and printing industry	17	1	19	8	2	47
Basic chemicals industry	52	3	3	4	1	63
Medicine and other chemicals	37	4	6	7	3	57
Petroleum and industrial gases	9	23	2	1	1	36
Rubber and plastic industry	16	1	3	4	–	24
Plastic goods industry	72	3	9	8	–	92
Construction industry	4	1	14	6	1	26
Production of construction materials	36	7	24	9	1	77
Earthenware industry	39	9	2	8	2	60
Basic metals industry	41	2	4	5	2	54
Aluminium joinery and metal goods	15	3	15	3	6	42
Steel construction and materials	25	5	15	6	3	54
Manufacture of metal tubes, cans and containers	33	–	6	11	4	54
Other metal supplies industry	63	–	2	1	–	66
Group of rolling mills	20	–	3	2	–	25
Special industrial machinery	21	1	8	–	5	35
Construction and care of other machinery	13	5	14	6	1	39
Automobile industry and side industry	51	1	9	6	1	68
Group of electrical machinery industry	28	–	3	4	3	38
Electrical equipment and cable industry	18	2	10	6	–	36
Others	19	14	18	7	4	62
Total	682	92	231	131	58	1,194

Note: There are three industrial firms in the food industry and one in metal industry functioning in Kandira

Table I.
Distribution of industrial firms registered at Chamber of Industry of Kocaeli by regions and sectors (2002)

Among firms controlled for wastewater disposals 54.5 per cent are in the metal, petrol, petrol products and chemical sectors, and most (69 per cent) are in region 1, with 19.9 per cent in regions 3 and 4 (Table III).

Overall only 30.7 per cent of the total number of firms are controlled. Table IV shows the analysis of the profile of the liquid waste derived from the firms controlled for their wastewater.

Industrial firms whose solid waste disposal is controlled by Kocaeli Provincial Directorate of Environment

KPDE has published the profiles of dangerous wastes of 47 industrial firms in Kocaeli, whose polluting aspects are very high; 24 are in region 1, five in region 2, nine in region 3, and nine in region 4. Dangerous and harmful waste materials from industrial firms of Gebze are: contaminated clothes, used resin, penetration oil, used powdered recine, halogenated solvent, mixture of fluid and powdered aromatic, solid solvent, acetone, organic solvent, racumin, distillated mud, filter clothes, mixed chemicals, chemical purification mud, footwear base form, black paste, buthanediol, polyols, isocyanates, latex, pyridines, package of medicine, used oil, glass container of solvent, expired medication, used package material, paint, varnish, mud, muddy water, waste of distillation, dust filters, mixed PVA alkyls, contaminated waste, wasted filter,

Sector	Number	Percent
Metal	101	30.1
Petroleum and its products	24	7.1
Earth, stone	8	2.4
Chemistry	58	17.3
Automobile	10	3.0
Cement	9	2.7
Food	37	11.0
Plastic	20	6.0
Carwash	4	1.2
Mine	2	0.6
Automobile side industry	8	2.4
Wood and furniture	6	1.8
Electric, electronic	12	3.6
Paper	7	2.1
Rubber	8	2.4
Abattoirs	1	0.3
Glass	4	1.2
Energy	2	0.6
Textile	7	2.1
Purification plant	2	0.6
Transportation	2	0.6
Ships construction	1	0.3
Health products	1	0.3
Information	1	0.3
Leather and leather products	1	0.3
Total	336	100.0

Note: From 39 firms it was impossible to obtain data

Table II. Distribution of industrial firms whose waste water is controlled by Kocaeli Provincial Directorate of Environment by sectors (2001)

Region	No. of controlled firms	Percentage of controlled firms	Total number of firms	Percentage of controlled firms in the total of firms
Region 1	254	69.4	682	34.3
Region 2	26	7.1	92	28.3
Region 3	33	9.0	231	14.3
Region 4	40	10.9	131	30.5
Region 5	9	2.5	58	15.5
Region 6	4	1.1	4	100.0
Total	366	100.0	1,194	30.7

Table III. Distribution of industrial firms whose waste water is controlled by Kocaeli Provincial Directorate of Environment by regions compared with the total number of firms in each region (2001)

phosphate mud, stropor, mixed thinner, herbicide, empty barrels, sodium fluoride, row material of TCA, toluene, some type of aerosol, hardener for acrylic, alkyl, phosphorus, vegetable oil and mastic, phenols, foam polyurethane, methanol, used label material, plastic parts of automobiles, emulsions, machine oil, ethylacrilate, laboratory chemicals, water contaminated with nitrobenzene, sample pots, oil of boron, oil of filters, thinner, hardened varnish hardener, fluid trichloroethylene, polycarbonate, painted clothes, and undercoat against rusting.

Discharge parameter	Region 1	Region 2	Region 3	Region 4
Lead	+	+	−	+
Cadmium	+	+	+	+
Sulphide	+	+	+	−
Chromium	+	+	+	+
Chlorine	+	+	+	−
Cyanide	+	+	+	+
Ammonium nitrite (NH4-N)	+	+	+	−
Iron	+	−	+	+
Zinc	+	+	+	+
Phosphorus	+	−	−	+
Mercury	+	+	+	+
Copper	+	+	+	+
Ammonia	+	+	+	−
Nitrogen	+	+	+	−
Cyanide	+	+	+	−
Aluminium	+	+	+	−
Fluoride	+	+	+	+
Nickel	+	+	+	+
Silver	+	+	+	−
Arsenic	+	−	−	−
Sulphide	+	+	+	−
Hydrocarbons	−	+	+	−
Phenol	−	+	+	−
Boron	−	+	−	−

Table IV.
Distribution of industrial firms whose waste water is controlled by the Kocaeli Provincial Directorate of Environment by region and waste water profiles

Dangerous and harmful waste materials from industrial firms of Korfez are: used paint, powdered waste material, watery lime, fungicide, contaminated herbicide, contaminated waste material, cyanical acid, and bottom mud of petroleum tank.

Dangerous and harmful waste materials from industrial firms of Izmit are: used packaging material, acidy mud, painted material, dirty sawdust, dry soap, dirty waste, oiled material, used separateur, oiled paper, acid powder, purification mud, copperbromure, printing paint, filter, polimerised carbon, contaminated clothes, finishing oil, solvent, watery lime, oil and water of turbine, mud of anodes, boxes of paint, painted mixed waste material, broken glass, automobile bathing wastes, stropor, used oil, cake of filter press, sample pots, and aluminium wire drawer oil.

Dangerous and harmful waste materials from industrial firms of Kosekoy are: used packaging material, used oil, used paint, isolation material, geotextile package waste, carbon black, laboratory chemicals, diesel oiled sawdust, pigment, waste of soaps, cement, oil traps, purification mud, mixed waste, contaminated clothes, used ink, spray lac, filter of oil, waste of emulsion, water of emulsion, mud of emulsion, condenser, powder of streata, package with carbonblack, mud of neutralisation, oiled mud, used grease oil, latex, thermocol, contaminated package material, and waste of laboratories.

Controlled industrial firms with high air polluting effects

BPAQ divides factories, in Kocaeli province whose polluting effects are high, into 18 categories depending on the pollutants they produce such as: dust, lead (Pb), cadmium (Cd), thallium, chloride (Cl), hydrogen chloride (HCl), inorganic chlorine compounds in the form of gas, hydrogen fluoride (HF), and inorganic fluoride compounds in form of

gas, hydrogen sulphide (H_2S), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxides (NO), saw dust, magnesium (Mg), carbon dioxide (CO_2).

In region 2 where there is an extensive petrochemical industry, there are further threats such as benzene, xylene, olefins, ethyl benzene, isopropyl benzene, trimethyl benzene, mercaptan and organic lead compounds.

Discussion

Turkish industrial firms are required to produce an "environmental effect assessment" (EEA) report in order to operate. The possession of the report is legally considered as an undertaking by the firm to reduce the harmful effects of its operations and not to surpass the permissible emission limit levels. The KPDE inspects those firms only if there is a complaint or doubt about the firm. Based on the data presented, we believe that it is not realistic to expect that firms will abide by the regulations and intentions in the EEA report. Periodic measurements of organic emissions are a necessary prelude to reducing of industrial emissions. But this would require sufficient technical staff and equipment at KPDE.

Controlled dangerous waste and air quality

In Kocaeli industrial firms must transfer their dangerous and harmful wastes under suitable conditions to the Establishment for the Burning of Dangerous Waste and for the Production of Energy, which is directed by IZAYDAS and which is within the scope of the Izmit Metropolitan Municipality Integrated Environment Project. In order to decide the appropriate burning method, the solid waste profile of 47 big firms using IZAYDAS for the disposal of their solid wastes should be known by the facility. Those profiles were used in this review to identify the threats emanating from solid waste of industrial firms, which is assumed to be representative.

The air pollution control teams of the KPDE go to industries that operate within the city, identify and sample their processes and emission sources. Measurements are made using the MRU chimney gas measurement tool. If deemed necessary, a change of fuel, cyclone, filtration etc. is requested. As the data provided by the KPDE does not contain sufficient information, we have used data from BPAQ in determining the pollutants that most affect air quality. We have determined to which group in the by-law the firms belong, and the pollutants defined for a given group are accepted as the pollutants of the corresponding factory.

The environmental threats emerging from the industrial firms controlled by the directorate of environment

Kocaeli represents an almost complete picture in terms of threats polluting the environment. The diversity of its industries involves the use of many chemicals. The use of so many processes during the production makes it impossible to determine and control the chemical pollutants. In Kocaeli, particular substance and SO_2 are measured in eight different fixed stations during a 24-hour period. According to the measurements of the KPDE, levels of particle substances and SO_2 have never exceeded recommended levels. Reliability of these results is questionable because Agri, a city in Eastern Turkey without industry, has higher values than Kocaeli.

According to the environment laws of Turkey, ambient pollutants that must be reported are: SO_2, CO, NO_2, Cl_2, HCl, Cl^-, HC, H_2S, particle substances (including Pb,

Cd and their compounds), and sediment powders (including Pb, Cd and their compounds) (Guler and Cobanoglu, 1996). Some of these substances are called primary pollutants and they exist in the air in the same form as when they directly came from the polluting source. They may reach a more advanced level of oxidation within the ozone layer of the atmosphere and are used to measure the degree of pollution in the air and photochemical reactions (Smoyer *et al.*, 2000). The intermediary substance, within the vapour of the atmosphere creates products like sulphuric acid, nitric acid, carbonic acid etc. that contributes to the formation of acid rains. This is called secondary pollution. In Kocaeli there exists both primary and secondary pollution.

Between air pollution and human mortality, research has demonstrated a statistically significant relationship (Schwartz and Dockery, 1992; Thurston, 1996). Lewis' study suggests the real impact of urban environment on child health began with the industrial revolution (Lewis, 2002), the starting-point of environmental pollution. Butorina and Butorina (2001) suggested that reduced industrial activity in Mariupol, which was one of the most polluted cities in the formerly USSR, has resulted in the level of environment pollution decreasing nearly twofold, but the quantity of hazardous wastes in the water, air, and soil has continued to exceed the WHO safety levels, with the result that city dwellers have unusually higher levels of oncological diseases. In the years of the USSR's industrial development, Mariupol became a city of metallurgic industries only. The diversity of industry in Kocaeli poses a more complex threat to the city.

In their paper Douglas *et al.* (2002) have tested the hypothesis that the human consequences of, and responses to, urban environmental issues are not simply cause and effect but technological situations, and the scene of constant adjustment, re-appraisal, response to changing attitudes and new technologies. They discussed the 200-year history of industry, environment and health in Manchester, which is a city in many ways comparable to Kocaeli (Douglas *et al.*, 2002). Kocaeli plays now in the locomotive role of industry in Turkey, the role that Manchester played 100 years ago in England. Turkey views Kocaeli as a kind of experiment, seeing the city as both an indicator of what economic progress really is, and as a warning of its environmental and social consequences. In Cubatao, Brazil, which had been widely known as one of the most polluted cities in the world, a successful program to control air, water, and soil pollution has been carried out. A temporary alliance between state technocrats and popular movements pushed the local polluting industries into complying with environmental legislation (de Mello Lemos, 2002). Interest in environmental issues lacks popular support in Kocaeli, and thus an alliance like that in Brazil seems to be improbable.

El-Hasan *et al.* (2002) have investigated the air quality in the industrial part of Amman, Jordan by analysing cypress tree bark samples and found that part of the city was characterised by high Zn, Mn, Cr, Ni and Co contents. They have attributed this to the fact that metals are common fuel additives especially in homes and factories. Not only did the emissions derive from the production process, but fuels used in the process pose serious threats to the health of neighbouring people. Beside the threats posed to health and safety by industrial activities, the urban concentration of industry, the logical result of industrial development, posed threats to the environment (Ezcurra and Mazari-Hiriart, 1996).

Kampala in Uganda has similar problems to Kocaeli. Industrial and residential premises occur side by side. There are 5,000 registered factories contributing 45 per cent of the gross domestic product of Uganda. Industries there contribute to pollution by air emissions, noise and wastewater discharge (Matagi, 2002). Most industries do not have proper methods for disposing of their wastes. Lead, copper, chromium, and zinc are the mostly found air pollutants in that city.

According to Haiyan, Zhuzhou in Hunan Province of China is an industrial city characterised by a heavy concentration of industries and, thus, severe pollution (Haiyan, 2002). He assesses and quantifies the present condition of the city's overall environmental status. The suggestions he proposes are the same as those that could be applied in Kocaeli: change the energy source, use cleaner fuels; produce cleaner to minimise the discharge amount of heavy metals and organics; and limit the discharge of heavy metals to the environment.

Conclusion

Kocaeli is a factory city with a wide range of industrial diversity. Both the number and the spatial concentration of the factories are very high. The unplanned and uncontrolled proliferation of industrial firms since 1960 has not only resulted in pollution derived directly from industry; but also indirectly due to unplanned city development. The fact that many factories are not controlled poses a serious pollution problem. Sustainable industrial development can only be realised by a balance between the production and handling of wastes. Prospective studies measuring the environmental effects of industry in the city should assess them both qualitatively and quantitatively.

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