WASD
OUTLOOK 2015

6

WORLD ASSOCIATION FOR SUSTAINABLE DEVELOPMENT

THE CONTRIBUTION OF ECONOMICS TO UNDERSTANDING ENVIRONMENTAL COST: A CASE STUDY OF ZILETEN CEMENT PLANT, 1990–2010

YUSEF Y. MASOUD

Libyan Open University, Libya

Head of Economic Department,
Libyan Open University, Tripoli, Libya
E-mail: Dr.yusef@yahoo.com

ABSTRACT

Purpose: This study considers how an increase in production costs following an action to reduce environmental pollution would be shared between the producer and the consumer. As such, it makes an interesting contribution to the literature on environmental economics by discussing, and modelling, how such a cost increase would be shared between the producer and the consumer.

Design/methodology/approach: The method used in the study is a descriptive and analytical (time series analysis and the application of microeconomic analysis tools) to determine the potential effects of environmental policy on the case study company. In essence, the study calculates price elasticities of demand and supply and applies an appropriate value for the cost of environmental improvement. Then the relative elasticities are used to determine producer and consumer shares of the cost increase. The student has selected one of the major cement producers in Libya – Zileten Cement Company and the study contacted on Zileten cement plant, and the period of time series of this study is 1990–2010.

Findings: The environmental policy on combatting the environmental pollution caused by the cement industry has led to an increase of the cement production cost. Therefore, the amount of additional cost will be borne almost equally between the producer and the consumer.

Originality/value: Thus, this study has provided a good basis for decision makers in Libya generally and the Zileten Cement Plant specifically. To know how much the environmental burden would be borne, a special table was developed to help the decision makers in cement industry (or those concerned with planning economic activity.) to know who will bear the burden of environmental cost; whether it is the producer or the consumer, and who would bear a larger amount of cost if both. This table, or distribution, is considered as a major contribution in this study which could be applied in any country or with any sort of industry which has an impact on the environment.

Keywords: consumer surplus; producer surplus; environmental cost; marginal cost; elasticity.

INTRODUCTION: LITERATURE REVIEW

This study has discussed many of the pollution issues caused by cement industry that have been raised in previous research, and the researcher found that this research focused basically on:

1. *Air pollution from the cement industry*: the researcher found that these papers discussed two main issues related to this point as follows:
   a. Some authors argue that there is a possibility to solve this problem (Alam and Shalkh, 2007; Anonymous, 1996a; Il'ina, 2008; Liblik et al., 2000; Lukjanova and Mandre, 2010). Other authors argue that it is only possible to reduce the pollution from this industry (Ning, 1997; Nordqvist et al., 2002). However, there is no perfect solution to this problem, at least at the current time, where many difficulties exist in applying these solutions (e.g. studies such as the Anonymous, 2008b and authors such as Magat, 1986; Ning, 1994; Teece, 1986; Wagner, 2004).
   b. Another research theme concerns the relative contribution of the cement industry to air pollution. Here some argue that the cement industry is the most powerful source causing air pollution, while others believe that cement is not the main source of air pollution (Abdul-Wahab, 2006; Ade-Ademilua and Obalola, 2008; Anonymous, 2008c; 2009d–f; Branquinho et al., 2008; Cherem da Cunha et al., 2008; Davidovits, 1994; EL-Fadel et al., 2003; Gosudarstvenny and Sostoyanii, 2005; Härtling and Schulz, 1998; Hendriks et al., 1999; Kabir and Madugu, 2010; Kuvarega and Taru, 2008; Mandre et al., 2008; Pacyna et al., 2006, 2007; Pyta et al., 2009; Razavi, 2006; Smith, 1990; Staaf and Tyler, 1995). Other researches, for example, Alam and Shalkh (2007) and Masoud (2007) emphasise the importance of cement in developing and developed countries.
2. *Alternative fuel*: given the reliance on fossil fuel in the production process one can identify a cluster of studies that discuss reducing pollution by focusing on finding an alternative to fossil fuel as follows:
   a. The first group discusses issues around the best alternative fuel. Some of them believe that organic and mineral fuels are good alternatives for fossil fuel (Contract Journal, 2006a; Hibbert, 2007; Huntzinger and Eatmon, 2009), while others believe that hazardous waste is a good alternative fuel for coal (Bowermaster and Carpenter, 1993; Kemezis, 1993). The third group believes that coal could be supplemented by waste (either hazardous or non-hazardous) rather than being replaced by waste alone. Jian et al. (2010) and a fourth group believes that tyres are the best alternative to fossil fuels (Johnson and Truini, 2002; Moore, 2003).
   b. However, of course, even alternative fuel will impact on the environment. Here a number of opinions believe that such an alternative will not have any adverse impact on the environment (Hibbert, 2007; Jian et al., 2010), while a second group of researchers fears the use tyres as an alternative fuel (Carpenter and Bowermaster and Carpenter, 1993; Moore, 2003). A third group believes that the burning of waste in cement kilns poses a threat to the environment (Mattos and Ribeiro, 1997; Porto and Fernandes, 2006). A fourth group of researchers find the burning of waste dangerous. However, if this is to be done in an organised way the risks could be reduced but with the condition of applying this for a temporary period only (Kemezis, 1993). Finally, there are other views which argue that good management of traditional fossil fuels could help in reducing the pollution (Contract Journal, 2006b).
   c. There is another group of research that focuses on the economics of utilising an alternative fuel. Some researchers believe that an alternative fuel is not economic when combined with the environmental burden. Another group believes that for oil producing countries – where the price of oil is relatively cheap – they do not need to search for an alternative fuel especially in the case of developing countries that produce oil, where the concern is only about growth coupled with little priority for environment aspects.

In fact, all the previous studies were good studies that have added several contributions. From the standpoint of the researcher, the search for an alternative fuel that causes less pollution to the environment is a good idea, and the first step. Particularly given that the cement industry causes a great deal of pollution to the environment. But unfortunately there is a real problem concerning the direct bearer of the environmental cost or environmental tax, which means the producers or the decision makers in the cement industry. If we supposed that there is a technology that could reduce pollution by a large amount, it is possible – of course – that developed countries focusing on cement production in their countries might use this new technology. The problem in developing countries might be than such a change would need enacting laws to be enforced. However, developing countries may not have the potential to apply and control legislation. Even in developed countries, governments cannot ultimately require managers in the cement industry to completely change their factories and lose their capital in order to apply a new technology that would help in reducing the environmental pollution.

So what is the solution, or what can be done, to convince companies in the cement industry to accept environmental burden (as a tax or installation of new techniques or equipment). Unfortunately, all previous studies – at least the ones that this researcher managed to find and discuss in this study – did not discuss this issue. This led the researcher to the belief that the issue of estimating the environmental burden cost and then clarifying who will bear this burden or cost is an important issue. It would help managers of cement factories to accept and discuss all types of environmental solutions by providing producers in the cement industry with an idea about what would happen to their profits after taking into account the environmental cost. However, in the opinion of the researcher, decision makers – especially those in developing countries – do not see themselves obligated to bear any of the environmental costs or other extra costs that would reduce their profits. Therefore, this study attempts not only to estimate the cost but also tries to determine the parties who will bear such a burden. This may well influence their decision making positively and to implement environment improvement. It is from this approach that the researcher believes that this study draws its strength and its contribution.

STUDY QUESTIONS

This study aims to answer the following two broad questions:

1. Is there the possibility that there are some economic instruments that can help our understanding of environmental cost?
2. Is it possible to determine the amount of the (technical) environmental cost of the cement industry? How is it possible to determine the (technical) environmental cost of the cement industry?

THE STUDY OBJECTIVES

This study aims to:

1. Having identified the general environmental cost of the cement industry to consider a method by which to consider the impact of the cost of environmental improvement on the producer and the consumer.
2. Know who will bear that environmental improvement cost and their relative share.

Estimating the production function of the cement for the Zileten cement factory

The production function for cement production could be considered as a function of two main factors as follows:

$$ĐĐĐ_{LD} = \left(\quad _1 \; D_1 \right)$$

$$CP_{ĐĐĐ} ℵ\alpha;ℵ \; \alpha \, \mathrm{RM} \quad \alpha \, D \quad U$$

Where CP_{LD} – the production quantity of the cement (ton per year by Libyan dinars) in the Zileten Cement Factory; RM_1 – the raw material used in cement production in the Zileten Cement Factory and D_1 – other inputs such as equipment and machinery, which can be expressed by the use of capital in the Zileten Cement Factory.

By assuming that the production function is a homogeneous degree of $b_1 + b_2$; the Cobb Douglas formula can be used in some cases, depending on the availability and robustness of the data, the precise economic situation of the factory and the degree of competitiveness in the economy. Since the late 1980s, Libya could probably be described as more of a capitalist than planned economy. So the use of the Cobb Douglas function is justifiable in this mixed economy.

$$CP_{LD} = ARM^{b1}D^{b2}$$

Also, the function can be formulated in a linear form and estimated by using the least squares method after converting it to the following form:

$$\mathrm{Log}CP_{LD} = \mathrm{Log}A + b_1\mathrm{Log}RM_1 + b_2\mathrm{Log}D_1 + U$$

Where:

$$CP_{LD} = \frac{\mathrm{Log}PC_{LD}}{\mathrm{Log}RM_1} = b_1$$

indicates the amount of change in production (CP_{LD}) which results from the change in the quantity of raw materials (RM_1) and assuming the stability of the quantity of other inputs used.

$$PC_{LD} = \frac{\mathrm{Log}PC_{LD}}{\mathrm{Log}D_1} = b_2$$

Indicates the amount of change in production (PC_{LD}) from the change in the material and inputs (D_1) by assuming the stability of the quantity of raw material used.

Estimate of production function the Zileten cement factory

$D \sum \mathrm{LogCP} =$ -0.159778 $\sum(\mathrm{LogCP}_{-}$ - 3.738011003 $\sum \mathrm{LogRM}_{-1}$ + 33.96009905) -0.821103 $\sum D \, \mathrm{LogCP}_{-1}$ -0.684717
P-Value 0.0260 0.0380 0.1324

$\sum D \, \mathrm{LogCP}_{-2}$ -0.841683 $\sum D \, \mathrm{LOGCP}_{-3}$ -0.338858 $\sum D \, \mathrm{LogCP}_{-4}$ -0.453831 $\sum D \, \mathrm{LogRM}_{-1}$ -0.376587 $\sum D\mathrm{LogRM}_{-2}$
0.0707 0.5791 0.1243 0.0828

-0.038580 $\sum D \, \mathrm{LogRM}_{-3}$ -0.235537 $\sum D \, \mathrm{LogRM}_{-4}$ + 0.353013 ....(1)
0.8973 0.3899 0.0459

R^2 = 0.732702 **D.W Test** = 2.092894

D $\sum CP$ = 1.003277($\sum CP_{-1}$ - 3.420998665 $\sum D1_{-1}$ -12354053.61) -1.543490 $\sum D\ CP_{-1}$ -1.374452 $\sum D\ CP_{-2}$ -
P-Value 0.0059 0.0021 0.0185
0.903089 $\sum D\ D1_{-1}$-1.787369 $\sum D\ D1_{-2}$+10930567 ……………………………………………………………(2)
0.3469 0.0555 0.0012

R^2 = 0.611966 **D.W Test** = 2.137777

From question (1) it could be deduced that all the independent variables were significant given the *T*-test at 10% ($P < 0.10$). As for the value of R^2; this value is high and equals 0.73. This means that the independent variables ($\Sigma DLogRM_{-2}$) were able to explain 0.73 of the changes in the cement production quantity (CP).

Moreover, The D.W test is a test for correlation in the residuals of a time series regression. A value around 2.0 for the D.W statistic indicates that there is no serial correlation. (Economics, 2011). By the way, the residual tests indicated to that the model does not several from serial correlation problem and normality problem as well.

Estimating the function of cost of pollution control from cement production in the Zileten Cement Factory

The quantity of emissions from the production of cement can be considered as a function of two main variables as follows:

$$MP_{LD} = MP_{LD}\left(RM_1, TechC_1\right)$$

$$MP_{ÐÐÐ} \aleph\beta ⁝ \aleph\beta\, RM \quad \beta\ TechC \quad U$$

where MP_{LD} – the quantity of the emission from the cement production in the Zileten Cement Plant. It is worth mentioning here that the contaminated dust represents 13.5% from the weight of cement production (Alalem, 1999; Department of Budgets, 1990–2010e; Department of Information Systems in the Zileten Cement Plant, 1990; Centre for Economic Research, 1997); RM_1 – the raw material which is used in the cement production in the Zileten Cement Factory. Thus row material variable was measured by lime stone cost, clay cost, gypsum cost and ferric oxide cost; $TechC_1$ – the Technology cost that controls the pollution level in the Zileten Cement Factory. A choice was made as to which were the main polluters as evidenced by dust, gas and soil contamination. Thus the technology cost variable was measured by the explosives cost, fuel cost, labour cost, gypsum transport cost and ferric oxide transport cost, since these are the main polluters.

Estimation of the emission function with raw material and the technology cost at the Zileten Cement Factory during 1990–2010

$\sum D$ MP = -0.551868 $\sum MP_{-1}$- 3.440645286 $\sum RM_{-1}$- 227618.9529)+ 0.321069 $\sum D(MP_{-1}$-2.560520 $\sum D\ RM_{-1}$
P-Value 0.0001 0.2057 0.0001
+ 36012.88 ………………………………………………………………………………………………(3)
0.8621

R^2 = 0.729912 **D.W Test** = 1.718651

$$\sum D\, MP = -0.507393 \left(\sum MP_{-1} - 3.348625558\, TC_{-1} + 1636394.259\right) + 0.271405 \sum D\, MP_{-1} - 1.627423 \sum D\, TC_{-1}$$

P-Value 0.0024 0.3977 0.0011

$$+\ 71506.50 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

0.7836

R^2 =0.583420 **D.W Test** = 1.296899

It could be concluded that, the independent variables were significant from a statistical aspect in both equations according to *T*-test at a significant level of 5. Question (3) shows that the coefficient of R^2 equals 0.73, which means that the independent variable of the raw materials (RM_1) could interpret 0.73 of the changes which happen with the quantity of polluting emissions while the remaining 0.27 is due to other factors.

Question (4) shows that the coefficient factor R^2 equals 0.60, which means that the independent variables are able to explain 0.60 of the changes which happen with the quantity of polluting emission while the remaining 0.40 is due to other factors.

Estimation of the environmental cost rate in the Zileten Cement Factory

By using the estimated values of the coefficients included in the marginal cost equation it has been found that the results of the coefficients are as follows:

$$MP_{LDTechC} = -1.627423,\ MP_{LDRM} = -2.560520,\ CPLDRM = -0.376587$$

P = 89.5 (This value of cement price has been taken from official report of Ahlia cement company).

Where the marginal cost before determining the cost of emission or pollution is as follows:

$$MC_o = \frac{89.5}{-0.376587} = -237.6608858$$

After determining the cost of pollution or emission and giving different values for P_{1TechC}, the value of the marginal cost could be determined after applying the cost of pollution as follows:

If putting P_{1TechC}–0.25 (LD).

$$MC_1 = \lambda_1 = \frac{P - P_{ÐÐÐÐÐÐÐ}\left(MP \quad / MP \quad _{C}\right)}{CP_{LDRM}}$$

$$MC_1 = \frac{89.5 - 0.25(-2.561 / -1.6274)}{-0.376587} = -236.6162045$$

So any increase of the environm ental cost by 0.25 Libyan Dinar per ton of cement in the Zileten Cement Factory will lead to an increase in the marginal cost by 1.821886064 Libyan Dinar.

ANALYSIS OF THE ELASTICITY OF DEMAND PRICE AND SUPPLY PRICE FOR CEMENT PRODUCTION

After analysing the production function of the cement industry and the emissions function, and having estimated the environmental cost of the Zileten Cement Factory, it becomes necessary for us to identify who will bear the cost of environmental pollution, whether it is the consumer or the producer or both. Of course, this will depend on the relative response of the producer and consumer to the changes in the price of the cement; the one who is more responsive to the price change will bear less of the cost increase. Those who are less responsive to the change of the price who will bear more of the cost.

Where EQD – Demand Price Elasticity; EQS – Supply Price Elasticity; *E* – Equal; *P* – Producer; *C* – Consumer; *U* – Unrealistic case.

THE ANALYSIS OF PRICE ELASTICITY OF DEMAND AND SUPPLY FOR THE ZILETEN CEMENT FACTORY

The following table illustrates the elasticity of demand price and the elasticity of supply price for the cement production in the Zileten Cement Factory calculated for the period 1988–2008, but due to the stability of the price of cement in Libya during some periods of time the elasticity could not be calculated during these times as shown in following Table 2. Thus, these years were excluded from the table for this reason, and the elasticity was calculated only for the years that witnessed a change in the cement price in Libya.

After the analysis of the elasticity of demand price and supply price of cement industry in the Zileten Cement Factory, it has been shown that the response of producer and consumer for changes which happen to the price per ton of cement production is going in the same direction. So any increase in the price per ton of cement, as for example the increase in the cost of pollution, will be divided almost equally between the producer and consumer but is more important here to point out that the producer will bear a little bit more than the consumer and that is according the result of elasticity in Table 2. This result supports the scenarios outlined in Table 1.

Table 1 Illustrated the environmental cost distribution (it could be used this distribution for any sort of businesses)

Elasticity		*EQS = 0*	*EQS < 1*								*EQS = 1*	*EQS > 1*			*EQS = ∞*
		0	*0.1*	*0.2*	*0.3*	*0.4*	*0.5*	*0.6*	*0.7*	*0.8*	*0.9*	*1*	*1.1*	*1.2*	*…*	*∞*
EQD = 0	0	U	C	C	C	C	C	C	C	C	C	C	C	C	C	C
EQD < 1	0.1	P	E	C ≥ P	C ≥ P	C ≥ P	C > P	C > P	C > P	C > P	C > P	C > P	C > P	C > P	C > P	C
	0.2	P	P ≥ C	E	C ≥ P	C ≥ P	C > P	C > P	C > P	C > P	C > P	C > P	C > P	C > P	C > P	C
	0.3	P	P ≥ C	P ≥ C	E	C ≥ P	C > P	C > P	C > P	C > P	C > P	C > P	C > P	C > P	C > P	C
	0.4	P	P ≥ C	P ≥ C	P ≥ C	E	C > P	C > P	C > P	C > P	C > P	C > P	C > P	C > P	C > P	C
	0.5	P	P > C	P > C	P > C	P > C	E	C > P	C > P	C > P	C > P	C > P	C > P	C > P	C > P	C
	0.6	P	P > C	P > C	P > C	P > C	P > C	E	C > P	C > P	C > P	C > P	C > P	C > P	C > P	C
	0.7	P	P > C	P > C	P > C	P > C	P > C	P > C	E	C > P	C > P	C > P	C > P	C > P	C > P	C
	0.8	P	P > C	P > C	P > C	P > C	P > C	P > C	P > C	E	C > P	C > P	C > P	C > P	C > P	C
	0.9	P	P > C	P > C	P > C	P > C	P > C	P > C	P > C	P > C	E	C > P	C > P	C > P	C > P	C
EQD = 1	1	P	P > C	P > C	P > C	P > C	P > C	P > C	P > C	P > C	P > C	E	C ≥ P	C ≥ P	C ≥ P	C
EQD > 1	1.1	P	P > C	P > C	P > C	P > C	P > C	P > C	P > C	P > C	P > C	P ≥ C	E	C ≥ P	C ≥ P	C
	1.2	P	P > C	P > C	P > C	P > C	P > C	P > C	P > C	P > C	P > C	P ≥ C	P ≥ C	E	C ≥ P	C
	…	P	P > C	P > C	P > C	P > C	P > C	P > C	P > C	P > C	P > C	P ≥ C	P ≥ C	P ≥ C	E	C
EQD = ∞	∞	P	P	P	P	P	P	P	P	P	P	P	P	P	P	U

Source: Author (2009).

Table 2 The elasticity of demand price and supply price for cement production in the Zileten Cement Factory

Year	*Cement price*	*Sales of cement*	*Quantity of the cement production*	*Elasticity of demand price*		*Elasticity of Supply price*		*Distribution of environmental burden*
				Value	*State*	*Value*	*State*	
1990	14.5	756,441	759,258	–	–	–	–	–
1991	14.5	802,239	818,432	–	–	–	–	–
1992	17.5	751,754	728,728	0.34653	Inelastic	0.61845	Inelastic	C > P
1993	17.5	781,621	835,742	–	–	–	–	–
1994	20.5	769,211	735,010	−0.10136	Inelastic	−0.81231	Inelastic	C > P
1995	20.5	673,063	719,679	–	–	–	–	–
1996	22.37	695,124	636,977	0.369651	Inelastic	−1.39752	Elastic	C > P
1997	22.37	564,598	539,018	–	–	–	–	–
1998	31.5	506,635	494,493	−0.31926	Inelastic	−0.25419	Inelastic	P ≥ C
1999	31.5	418,391	378,329	–	–	–	–	–
2000	31.5	614,706	589,193	–	–	–	–	–
2001	31.5	715,881	674,831	–	–	–	–	–
2002	31.5	773,074	759,344	–	–	–	–	–
2003	31.5	718,772	722,110	–	–	–	–	–
2004	38.5	658,971	670,568	0.43405	Inelastic	−0.37009	Inelastic	P ≥ C
2005	58.5	785,059	822,139	0.423486	Inelastic	0.492474	Inelastic	C ≥ P
2006	58.5	835,936	807,436	–	–	–	–	–
2007	62.5	824,204	839,276	−0.21377	Inelastic	0.584899	Inelastic	C > P
2008	74.25	777,070	776,302	−0.34258	Inelastic	−0.43365	Inelastic	C ≥ P
2009	79.25	612,478	600,428	−3.63642	Elastic	−3.9158	Elastic	C ≥ P
2010	89.75	736,188	752,237	1.476379	Elastic	1.806362	Elastic	C ≥ P

Source: Author (2014).

Based on this analysis, it can be recommended to the producer to apply the economic environmental policy, as they will not be bearing the costs of pollution only by themselves as the cost will be shared with the consumer almost equally.

THE RESULTS OF THE STUDY

This study has found eight results are as following:

1. The environmental policy on combatting the environmental pollution caused by the cement industry has led to an increase of the cement production cost, which would result in lower output (production quantity). This reduction in income (increase in operating costs) could divert funding away from increasing the output of cement and growing this vital industry.
2. It could be noted from the results of analysis of the demand price elasticity and the supply price elasticity of cement production in Zileten cement Plant, that the elasticity of the demand price and the supply price are not elastic (are inelastic), which means that the amount of additional cost will be borne almost equally between the producer and the consumer. Therefore, the environmental cost will be shared almost equally between the consumer and the producer. This is as indicated in the distribution Table 1.
3. There are many studies on the pollution problem and, in particular, the problem of pollution caused by the cement industry, most of these studies discuss the issue from several

aspects, such as production technology, alternative fuels, emission levels and their impact on air and others aspects of life such as agriculture, earth, humans and others. But unfortunately only a small number of studies attempted to consider those two important parties in the cement industry, the producer who will face less profits or losses if new technical installations that cause less pollution to the environment are installed and also the consumer who needs this material in their life. So this study attempted to discuss the possibility of estimating the cost of pollution control as well to provide an economic analysis, and an explanation to the producer and the consumer. This explanation concerning the environmental cost, and its impact on the price and additional cost which will be borne by the producer and the consumer for this environment protection.

4. The application of an environmental economic policy in the cement industry will have an impact on other industries which for their production depend upon cement material.

THE CONCLUSION

The target of this study was to identify the impact of the environmental burden on the cement industry in Libya, in particular, the Zelition cement Plant during the period 1990–2010.

Many previous studies which discuss the pollution problem caused by the cement industry have been offered, and each study has a particular viewpoint. However, these studies raised many important points about this issue by considering the problem of air pollution, alternative fuel sources and the technology which relates to the cement industry, as well as other important aspects of human life.

Finally, this study has added to the work on the cement industry in Libya and set out to give an estimate of the environmental cost for this industry.

REFERENCES

Abdul-Wahab, S.A. (2006) 'Impact of fugitive dust emissions from cement plants on nearby communities', *Ecological Modelling*, Vol. 4, pp.338–348.

Ade-Ademilua, O.E. and Obalola, D.A. (2008) 'The effect of cement dust pollution on Celosia Argentea (Lagos Spinach) Plant', *Journal of Environmental Science and Technology*, Vol. 1, No. 2, pp.47–55.

Alalem, A.A. (1999) *The Possibility of Applying Economical Environment Policy to Reduce Industrial Pollution Effects*, Garyouins: University of Garyouins.

Alam, S.M. and Shalkh, A.H. (2007) 'Role of cement in country economy', *Economic Review*, Vol. 38, pp.76–77.

Anonymous (1996a) 'Novel method for NOx removal-two birds from a single shot', *Chemical Business, Pit and Quarry*, Vol. 9, p.25.

Anonymous (2008b) 'Nearly $400,000 penalty assessed for alleged violations of Portland cement MACT and State Requirements', *The Air Pollution Consultant*, Vol. 18, No. 4, p.3.

Anonymous (2008c) 'A large black cloud', *The Economist*, Vol. 386, p.13.

Anonymous (2009d) 'Settlement Requires California Cement Manufacturer to Pay $2 Million penalty and reduce emissions', *The Air Pollution Consultant*, Vol. 19, No. 30, pp.3–13.

Anonymous (2009e) 'New emission standards proposed for Portland cement plants', *The Air Pollution Consultant*, Vol. 19, No. 4, pp.2–5.

Anonymous (2009f) 'EPA issues final response to petitions for reconsideration of hazardous waste combustor MACT', *The Air Pollution Consultant*, Vol. 19, No. 1, pp.2–20.

Branquinho, C., Gaio-Oliveira, G., Augusto, S., Pinho, P., Maìguas, C. and Correia, O. (2008) 'Biomonitoring spatial and temporal impact of atmospheric dust from a cement industry', *Environmental Pollution*, Vol. 151, No. 2 I, pp.292–299.

Bowermaster, D. and Carpenter, B.A. (1993) 'The cement makers -long, sweet ride', *U.S. News and World Report*, Vol. 115, p.51.

Centre for Economic Research (1997) 'The possibility of using the alkali dusts of cement', *Journal of Industrial Research*, Vol. 7, pp.1–229.

Cherem da Cunha, A.L., Gonçalves, J.P., Büchler, P.M. and Dweck, J. (2008) 'Effect of metakaolinpozzolanic activity in the early stages of cement type II paste and mortar hydration', *Journal of Thermal Analysis and Calorimetry*, Vol. 92, No. 1, pp.115–119.

Contract Journal (2006a) 'Cement cleans up its act', Vol. 434, p.59.

Contract Journal (2006b) 'Product Materials', Vol. 434, p.35.

Davidovits, J. (1994) 'Global warming impact on the cement and aggregates industries', *World Resource Review*, Vol. 6, pp.263–278.

Department of Budgets (1990–2010e) *Zileten Cement Plant*, Zileten, Libya.

Department of Information Systems in Zileten Cement Plant (1990) *Manual*, Zileten, Libya.

EL-Fadel, M., Kobrossi, R. and Metni, M. (2003) 'Economic benefits of reducing particulate and sulfate emissions from the cement industry in Lebanon', *Journal of Environmental Assessment Policy and Management*, Vol. 5, pp.99–120.

Gosudarstvenny, I.O. and Sostoyanii, O.P. (2005) *State Report on the State of Natural Environment in Bryansk Oblast, 2005*, Bryansk, 2006.

Hara, C., Segal, I. and Tadlis, S. (1997) *Solutions Manual for Microeconomic Theory*, New York: Oxford University Press.

Härtling, S. and Schulz, H. (1998) 'Biochemical parameters as biomarkers for the early recognition of environmental pollution in Scots pine trees. I. Phenolic compounds', *Zeitschriftfür Naturforschung*, Vol. 53c, pp.331–340.

Hendriks, C.A.E., Worrell, L., Price, N., Martin, N. and Ozawa Meida, L. (1999) 'Greenhouse Gases from cement production in the Reduction of Greenhouse Gas. R and D Programme'.

Hibbert, L. (2007) *Concrete Solution; Professional Engineering*, Vol. 20, pp.22–23.

Huntzinger, D.N. and Eatmon, T.D. (2009) 'A life-cycle assessment of Portland cement manufacturing: comparing the traditional process with alternative technologies', *Journal of Cleaner Production*, Vol. 17, No. 70, pp.668–675.

Il'ina, T.N. (2008) 'Reduction in dust carry-over from a rotary cement kiln', *Chemical and Petroleum Engineering*, Vol. 44, No. 9, pp.589–596.

Jian, J., Xiaodong, L., Yong, C. and Jianhua, Y. (2010) 'Co-disposal of heavy metals containing waste water and medical waste incinerator fly ash by hydrothermal process with addition of sodium carbonate: a case study on Cu(II) Removal', *Water, Air and Soil Pollution*, Vol. 209, Nos. 1–4, pp.391–400.

Johnson, J. and Truini, J. (2002) 'Rock hard guidelines -cover story', *Waste News*, Vol. 8, pp.1–2.

Kabir, G. and Madugu, A.I. (2010) 'Assessment of environmental impact on air quality by cement industry and mitigating measures: a case study', *Environmental Monitoring and Assessment*, Vol. 160, No. 1, pp.91–99.

Kemezis, P. (1993) 'EAP gets heat on haz-waste kiln', *Engineering News*, Vol. 231, p.34.

Kuvarega, A.T. and Taru, P. (2008) 'Ambiental dust speciation and metal content variation in TSP, PM10 and PM2.5 in urban atmospheric air of Harare (Zimbabwe)', *Environmental Monitoring and Assessment*, Vol. 144, No. 1, pp.1–14.

Liblik, V., Pensa, M. and Kundel, H. (2000) 'Temporal changes in atmospheric air pollution in industrial areas of Ida- and Lääne-Viru counties', *MetsanduslikudUurimused, Forestry Studies*, Vol. 33, pp.17–36.

Lukjanova, A. and Mandre, M. (2010) 'Effects of alkalization of the environment on the anatomy of scots pine (Pinussylvestris) Needles', *Water, Air, and Soil Pollution*, Vol. 206, No. 1, pp.13–22.

Magat, W.A. (1986) 'Environmental economics and management', *Journal of Environmental Economics and Management*, Vol. 5, p.1.

Mandre, M., Kask, R., Pikk, J. and Ots, K. (2008) 'Assessment of growth and stem wood quality of Scots pine on territory influenced by alkaline industrial dust', *Environmental Monitoring and Assessment*, Vol. 138, No. 1, pp.51–63.

Masoud, A.A. (2007) *Economic Development and its Impact on the Environment*, Libya, Postgraduate: The Academy of Postgraduate.

Mattos, U.A.O. and Ribeiro, F.S.N. (1997) 'Co-processing of chemical residue and its impact on worker's Health and Environment: The case of the Cantagalo cement Industry/Brazil', *Proceedings of 13th Triennal congress of the International Ergonomics Association*, Tampere, Finland, 29 June–July, pp.450–452.

Moore, M. (2003) 'Tires-For-fuel grant burns environmental group', *Rubber and Plastics News*, Vol. 32, pp.5.F.

Ning, C. (1994) 'Management of the environment', Vol. 6, p.24.

Ning, C. (1997) 'Diffusion and adoption of environmentally sound technology in China cement industry', *Journal of Environmental Sciences*, Zhejiang University, China, Vol. 9, pp.321–328.

Nordqvist, J., Boyd, C. and Klee, H. (2002) 'Three Big CS -Climate, Cement and China', *World Business Council for Sustainable Development*, Switzerland, pp.69–82.

Pacyna, E.G., Pacyna, J.M., Fudala, J., Strzelecka-Jastrzab, E., Hlawiczka, S., Panasiuk, D., et al. (2007) *Atmospheric Environment*, Vol. 41, No. 38, pp.7–40.

Pacyna, E.G., Pacyna, J.M., Steenfuisen, F. and Wilson, S. (2006) *Atmospheric Environment*, Vol. 40, No. 22, pp.3–41.

Porto, M.F.S. and Fernandes, L.O. (2006) 'Understanding risks in socially vulnerable contexts- The case of waste burning in cement kilns in Brazil', *National School of Public Health*, Brazil, Vol. 44, pp.241–257.

Pyta, H., Rosik-Dulewska, C. and Czaplicka, M. (2009) 'Speciation of ambient mercury in the upper Silesia region, Poland', *Water, Air, and Soil Pollution*, Vol. 197, No. 10, pp.233–240.

Razavi, M.M.S. (2006) *Air Pollution in Iran and Recommended Equipment*, Dallas, United States: The University of Texas.

Smith, W.H. (1990) *Air Pollution and Forests. Interactions between Air Contaminants and Forest Ecosystems*, 2nd Edition, New York: Springer.

Staaf, H. and Tyler, G. (1995) 'Effects of acid deposition and tropospheric ozone on forest ecosystems in Sweden', *Ecological Bulletin*, Vol. 44, Copenhagen: Munksgaard.

Teece, D.J. (1986) *Research Policy*, Vol. 15, p.285.

Wagner, M. (2004) *Firms, the Framework Convention on Climate Change and the EU Emissions Trading System. Corporate Energy Management Strategies to Address Climate Change and GHG Emissions in the European Union*, Lüneburg: Centre for Sustainability Management, p.12.

BIOGRAPHICAL NOTES

Yusef Y. Masoud obtained his doctorate degree in Economics from a Business School, University of Huddersfield. Currently, he is a Lecturer in Economics and Head of Economics department at Libyan Open University, Tripoli, Libya. He is an expert on econometric models analysis and microeconomics. He has published more than 18 scholarly articles in academic journals, conference. He was a Head of an Administrative and Financial Affairs Department and also Administrative and services Affairs Unite in a Higher Centre of Computer, Tripoli, Libya, during 2000–2002. He also was a Manger of a Higher studies Office and a Head of Economic Department in Economic Facility, Serit University, Libya, during 2002–2006. He had previously been a Manger of Quality and evaluation performance office, Serit.