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Industrial development and the trade-off to environment: measurement techniques, meanings and outcomes in the context of water poverty in Egypt

Doaa Salman

Faculty of Management Sciences,
October University for Modern Sciences and Arts (MSA),
Intersection 26 of July Road and Wahat Road, October City, Egypt
Fax: 00202374037609
E-mail: doasalman@yahoo.com
E-mail: doasalman@msa.eun.eg

Abstract: Industrialisation is one of the main pillars of economic development but it is usually associated with significantly negative impacts on the environment. Environmental damage impedes development efforts; destroys resources; especially water; and redirects government objectives towards reducing pollutants emission. This study aims to estimate the pollution load for the industrial sectors in Egypt using industrial pollution projection system (IPPS), with respect to employment. These projections are based on the four-digit levels in the international standard industrial classification (ISIC). The purpose of such estimation is to provide an assessment to quantify the effects of the industrial pollution in Egypt, to guide the regulatory framework with information to prioritise its monitoring efforts, and more efficient managing of resources. It also addresses the potential consequences of industrial pollution on water poverty.

Keywords: industrial pollution projection system; IPPS; pollution intensity; international standard industrial classification; ISIC; employment; development; water poverty; pollution load; Egypt.

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Biographical notes: Doaa Salman is an Assistant Professor of Economics at the University of MSA – Egypt. She obtained her PhD from Ain Shams University. Her current research interests relate primarily, though not exclusively, to two areas: institutional setting and regulation to environmental problems, and the role of competitiveness and technology to deepen development.

1 Introduction

People all over the world are confronted with the pressing challenge of water pollution. The complexity of the challenge of water pollution is based on the different scenarios that

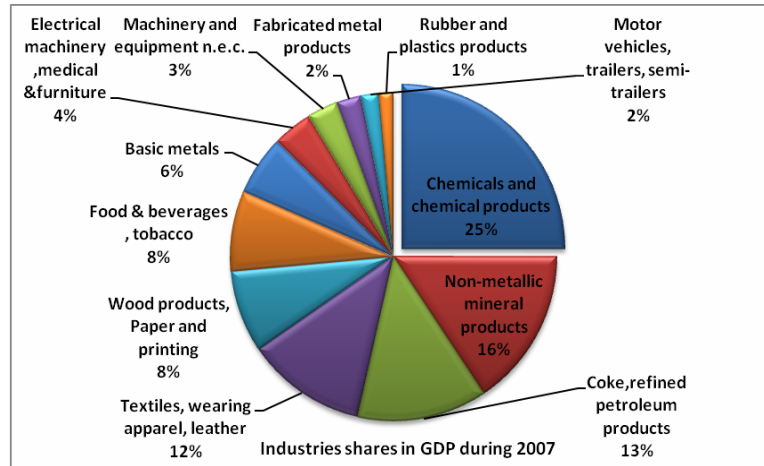
pollution can take, and variations in scale, local, regional or global – at which pollution can develop. All the world's largest rivers including the Ganges, Yangtze, Mississippi, Nile and even the Amazon need careful environmental assessment to protect them from environmental deterioration. To avoid deterioration they require sustainable management due to increasing human pressures on global freshwater resources (Meybeck et al., 1989; Chapman, 1992; UNEP, 1999).

In Egypt the River Nile provides more than 95% of its freshwater resources; the agricultural sector demands more than 86.4% of the total water supply, whereas, the industrial and domestic water demands constitute 7.7% and 5.8% respectively (FAO, 2008). These continuous demands put the river Nile under increasing pressure from population growth and industrial development, and it is vital that an ecological assessment is incorporated into a programme to manage the Nile, under the terms of the Convention for Sustainable Development. Moreover, Egypt's economic growth has been accompanied by a growth in energy use, consequently, increasing the level of pollution that is highly related with the industry composition, which was characterised by a significant increase in the heavily polluting industries.

During the last 50 years, industrial development was a major feature in Egypt as a result of development in construction movement. The industrial base was the prime source of goods and services, employment, and national wealth that sustains economies. Interestingly, industry's role in achieving national development strategies has increased, but this expansion in industrialisation without previous environmental planning has led to environmental deterioration in the form of different industrial pollution scenarios (water, air, and soil). The problem in Egypt is based on the concentration of the majority of industries and inhabitants being situated beside the Nile valley and delta. This concentration has resulted in all forms of pollution especially water pollution; as many industrial firms release waste in the Nile River. The Nile River is one of the world's largest rivers – it flows 1,350 km from the Aswan High Dam, to its discharge into the Mediterranean Sea. The annual discharge from the Aswan High Dam is 90 km³, although less than 25% of this flow ultimately reaches the Mediterranean due to evaporation and abstraction for irrigation. Within the catchments in Egypt there is a human population of over 75 million.

Researchers have estimated that the environmental problems resulting from industry represent 23% of total pollution in Egypt, the same percent as vehicle exhaust, and followed by 12% from burning municipal waste (Moussa and Abdelkhalek, 2007). The role of the Egyptian industrial sector was crucial in economic development as it contributed to the growth in gross domestic product (GDP) and attracts local employees. The petroleum industry is one of the most dynamic and flourishing sectors in the Egyptian economy, chemical products rank first with its participation in the GDP by 25%; non-metallic mineral products by 15.6%; refined petroleum by 12.9%, accounting for 30% of the country's exports, and providing for 95% of Egypt's energy needs. Moreover, textiles, wearing apparel account for 11.9% (see Figure 1) of total exports. Thus, while the textile and apparel industry in Egypt appears to be one of the strongest candidates for driving growth through global supply chains, industry faces significant challenges in growing into international markets due to severe competition.

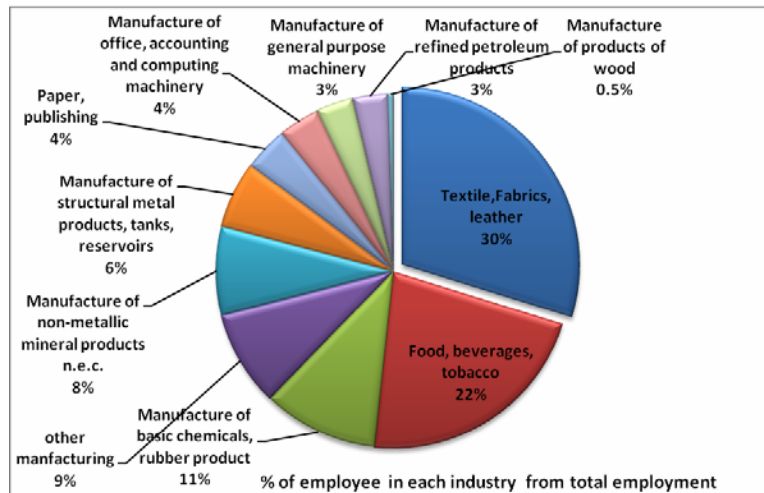
Figure 1 Egyptian industries shares in GDP during 2007 (see online version for colours)



Source: UNIDO (2009); data calculated by the author

Furthermore, the industrial sector in Egypt attracted around 948,350 employees in 2007. Figure 2 illustrates that around 30% of total employees were working in the textile industries; 22%, related to its long tradition in textile, locally available raw materials, competitive labour and utility costs. Manufacture of basic chemicals such as rubber product counts for 10.5% of employees, and 8% in manufacturing of non-metallic mineral products.

Figure 2 Relative importance of each industry according to number of engaged employee – 2007 (see online version for colours)



Source: UNIDO (2009); data calculated by the author

The Egyptian Government has become increasingly aware of the challenges posed by the rapidly growing demands for freshwater, together with Egypt's fixed annual water share of the Nile River. Within this limitation of water resources, and the government aims to

bound pollution (rather than it become unavoidable), to minimise the sources of industrial pollution emission. This problem requires up to date information, and data about pollution load of each industry in order to take the appropriate effective environmental actions.

1.1 Research objectives

The main goal of this paper is to estimate the pollution load for the industrial sectors in Egypt using industrial pollution projection system (IPPS), with respect to employment and output. IPPS will enhance pollution control in identifying the most polluting industrial sectors in developing countries, reducing cost, time and increasing the level of enforcement. Projections are based on the four-digit levels in the international standard industrial classification (ISIC), and assessing the status of water quality in Egypt. The target of this estimation is to guide the regulatory frame work with information to prioritise its monitoring efforts, and to manage quality of water more efficiently.

1.2 Methodology

This study uses the IPPS modelling system which combines data from industrial activity (such as production and employment) with data on pollution emissions to calculate pollution intensity factors, i.e., the level of pollution emissions per unit of industrial activity (define as pollution per unit of output or pollution per unit of employment) (Hettige et al., 1994; Benoit and Craig, 2001); with respect to the three key economic variables – total output, value added and employment. The following section will estimate the pollution load of industrial sectors in Egypt using IPPS pollution intensity with respect to employment. This was based on the four digit levels of aggregation in the ISIC for each type of pollution. Pollution intensities have initially been calculated with data available in the USA from the US Manufacturing Census (MC) and the US Environmental Protection Agency (EPA).

1.3 Data

The main sources of data were the US MC and the US EPA. The MC contains information for approximately 200,000 plants in the USA, while EPA maintains a number of databases on pollution emissions. These include the toxics release inventory (TRI), the aerometric information retrieval system (AIRS), the national pollutant discharge elimination system (NPDES), the human health and eco-toxicity database (HHED) and the longitudinal research database (LRD). All of these datasets have been used in the calculation of pollution intensities for approximately 20,000 plants.

Employment data of industrial sectors in Egypt available from the UNIDO 2007; is used for estimating pollution load in ton/yr; the lower bound (LB) pollution intensities by medium with respect to employment were obtained from the literature (Hettige et al., 1994). Moreover, Hettige et al. (1994) has shown that the ranking of industrial sectors was almost identical whether the values of output, or employment were used as the unit of measurement in the USA (Hettige et al., 1995). Therefore, the choice of the unit of measurement would not appear to impact the ranking of industrial sectors by their pollution load. This was used to calculate the pollution load for the ten major industrial sectors, according to ISIC code, to conform to ten major sectors in Egypt.

2 Industrial pollution scenarios

2.1 Air pollution

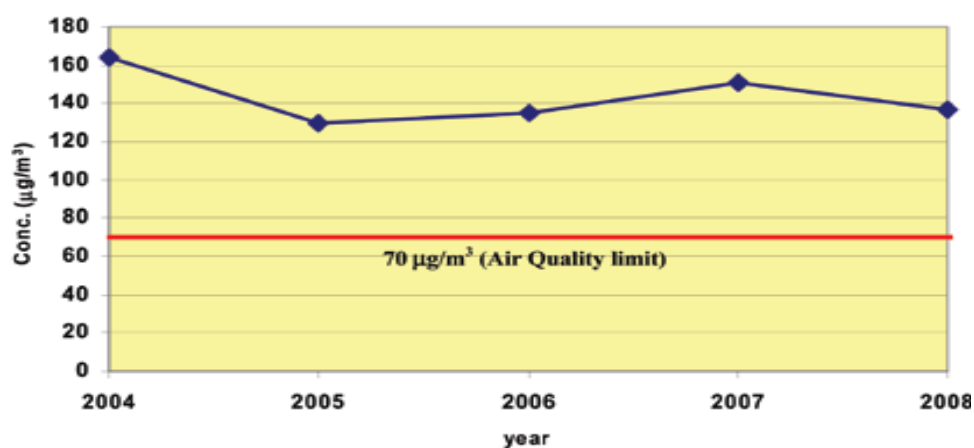
Emission into the air was estimated based on emission of total suspended particulate (TSP); sulphur oxide (SO₂); nitrogen oxide (NO₂); carbon monoxide (CO); fine particulate (FP) and volatile organic carbon (VOC) whose pollution intensities were available (Hettige et al., 1994).

Studies classify emission into suspended particulate and gaseous. Suspended PM can be categorised according to total suspended particles: the finer fraction, PM₁₀, and the most hazardous, PM_{2.5} (median aerodynamic diameters of less than 10 microns and 2.5 microns, respectively). Much of the PM_{2.5} consists of secondary pollutants created by the condensation of gaseous pollutants – for example, SO₂ and NO₂.

Types of suspended PM include diesel exhaust particles; coal fly ash; wood smoke; mineral dusts, such as coal, asbestos, limestone, and cement; metal dusts and fumes; acid mists (for example, sulphuric acid); and pesticide mists (Katsouyanni, 2003). While, gaseous pollutants include sulphur compounds such as SO₂ and sulphur trioxide; CO; nitrogen compounds such as nitric oxide, NO₂, and ammonia; organic compounds such as hydrocarbons; volatile organic compounds; polycyclic aromatic hydrocarbons (PAHs) and halogen derivatives such as aldehydes; and odorous substances. Volatile organic compounds were released from burning fuel (gasoline, oil, coal, wood, charcoal, natural gas, and so on); solvents, paints, glues, and other products commonly used at work or at home. Volatile organic compounds include such chemicals as benzene, toluene, methylene chloride, and methyl chloroform.

The Egyptian Environmental Affairs Agency (EEAA, 2008) measured the annual inhaled particulates concentrations during the previous five years (2004–2008), and showed that, the annual average concentrations in 2007 and 2008 were 151 µg/m³ and 137 µg/m³ successively. Although, the concentration decreased, it still exceeded the annual average permissible limits of environmental law (70 µg/m³) (Figure 3).

Figure 3 The annual average concentration of suspended particulates (PM₁₀) during 2004–2008 in Egypt (see online version for colours)



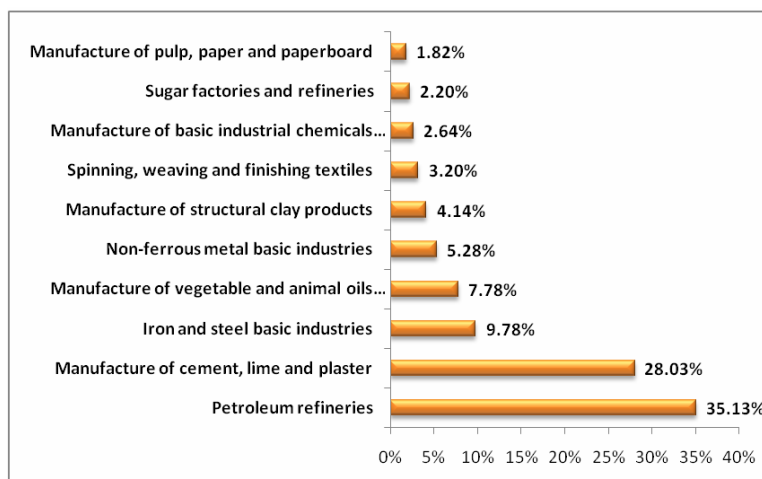
Source: EEAA (2008)

The figure illustrates a marked a reduction in dust concentration in all monitoring stations measured during 2008 when compared 2004 and 2007 levels.

2.1.1 Ranking industries according to air pollution

In Egypt, the petroleum refiners industry rank highest in their contribution to air pollution load by 35.1%, followed by the cement industry with 28.3%, and then the iron and steel industry with a contribution of 9.78% (Figure 4). According to the Ministry of Environmental Affairs, and the EEAA reports in 2004 conclude that the petroleum sector was responsible for 9% of the particulate air pollution while other non-fuel industry contribute with 23%.

Figure 4 Ranking industries according to their contribution in air pollution load (see online version for colours)



Source: Data calculated by the author (Appendix – Table 4)

Air pollution in developing countries presents a burden as it is responsible for many diseases, including chronic obstructive pulmonary disease (COPD), asthma, acute respiratory disease, and ischemic heart disease, with links to cancer, fetal abnormalities, low birth weight, and other less documented effects (Krewski et al., 2005; Yang et al., 2004; Goldberg and Burnett, 2005). The other diseases mentioned above fall far below 1% of the disease burden. In the lower-mortality developing countries, respiratory infections slide to third place (4.1%), with COPD (3.8%) and ischemic heart disease (3.2%) making it into the top 10 leading diseases (Ezzati et al., 2003).

2.2 Water pollution

Chemicals can enter running water from a point source or a non-point source. Point source pollution is due to release from a single source, such as an industrial site, while non-point-source pollution involves many small sources that combine to cause significant pollution. For instance, the movement of rain or irrigation water over land picks up pollutants such as fertilisers, herbicides, and insecticides, and carries them into rivers,

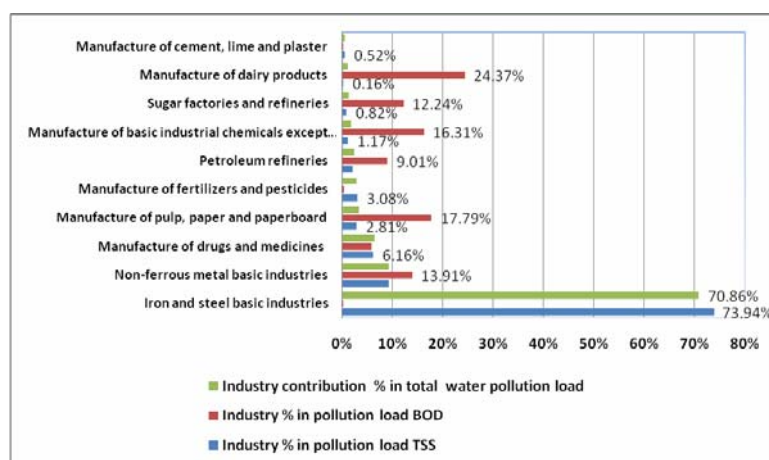
lakes, reservoirs, coastal waters, or groundwater. Another non-point source was storm water that collects on roads and eventually reaches rivers or lakes (World Bank, 1999).

Moreover, Industrial wastewater was one of the main sources of pollution in the River Nile, canals and drainages that may penetrate into groundwater if it is illegally pumped into the soil. The main sources of pollution included: biological oxygen demand (BOD); created by organic waste decaying in the water body. Major sources of BOD were pulp, and paper mills and municipal sewage. If dissolved oxygen was depressed to zero, all fish died, and anaerobic (i.e., without oxygen), decomposition generates noxious gases (e.g., hydrogen sulphide). Also, total suspended solids (TSS), which are small non-poisonous non-organic particles that threaten the natural water system.

2.2.1 Ranking industries according to water pollution

It is estimated that the iron and steel industry contribute with 73% from TSS; non-ferrous metal basic industries with 9.24%; manufacturing of drug and medicine by 6.16%. While, manufacture of dairy products participate by 24.37% from BOD in water pollution load; followed by 17.9% in the manufacturing of pulp, paper and paperboard (Figure 5). The water pollution load projection shows that the iron and steel industry contributes by 70% in water pollution followed by the non-ferrous metal, and manufacturing of drugs by 6.5%. Chemical industries contributes in pollution with heavy metals, organic and inorganic chemicals.

Figure 5 Ranking industries according to its contribution in water pollution load (see online version for colours)



Source: Data calculated by the author (Appendix – Table 5)

About 129 industrial facilities were located along the Nile River or the water courses among which 102 industrial facilities release their waste product directly or indirectly (about 4.047 BCM/year) into the River Nile; some of these facilities stopped disposing of waste completely. While, others comply with law no. 48/1982 and law no. 4/1994 regarding protection of the Nile, and water streams from pollution. On the other hand, violating facilities were committed to implementing an environmental compliance plan to adjust their conditions, and legal procedures were taken against other violating facilities (EEAA, 2008).

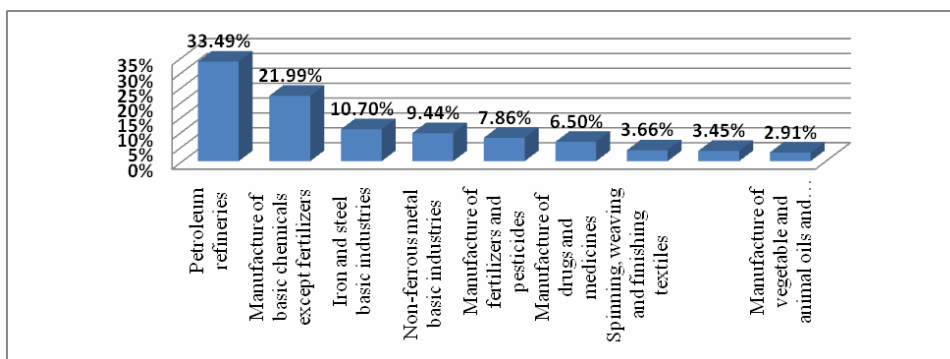
2.3 Chemical toxic materials

Toxic materials can affect the health of aquatic organisms, and their consumers, and those drinking contaminated waters. Toxicants include heavy metals (e.g., lead, mercury), chlorinated hydrocarbons (e.g., DDT, PCBs), PAHs (e.g., benzopyrene) and phthalates (e.g., dibutyl phthalate). They originate from many sources as a result of the large quantities of chemicals used in industries. Mixtures of toxic materials can be toxic even if their individual concentrations are below lethally toxic levels. Common toxic chemicals considered in estimating toxic chemical pollution intensity, include residues of pesticides, and a very large group of organic chemicals, which include benzene, toluene, xylene, chloroethane, and chloromethane, etc. (Hettige et al., 1994)

2.3.1 Ranking pollutant industries according to total chemical toxic pollutants

Petroleum refiners contribute with 33.49% of total chemical toxic pollutants; manufacturing of basic chemicals except fertilisers with 22%, and the Egyptian iron and steel industries with 10.7% (Figure 6). While the manufacturing of vegetable and animal oil, and manufacture of synthetics plastics have little contribution to total toxic chemical pollution.

Figure 6 Ranking pollutant industries in percentage according to their participation total chemical toxic pollutants (see online version for colours)



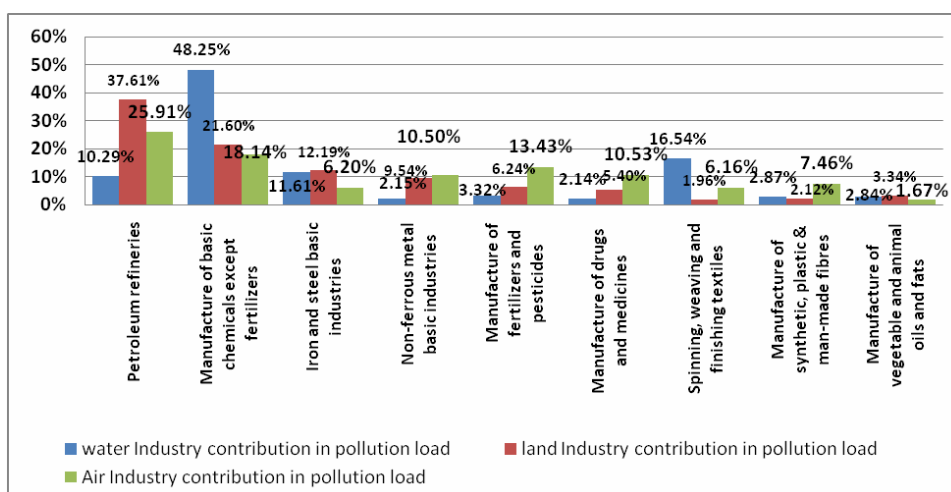
Source: Data calculated by the author (Appendix – Table 6)

Egypt has nine refineries that were able to process 726,250 bbl/day of crude. Other sources include manufacturing processes such as pulp and paper industry, textile and leather dyeing, and thermal processing in the metallurgical, cement, motor vehicles industry, and steel production processes. Petroleum hydrocarbons were potentially the most likely source of PAHs (Barakat et al., 2001; Barakat, 2002). Oil pollutants are toxic and may also smother aquatic organisms and cause the death of birds, attracted by the appearance of calm water, and by destroying the waterproofing properties of their plumage.

2.3.2 Ranking pollutant industries in percentage according to their participation total chemical toxic pollutants in air, water and land

Toxic chemical pollution load in ton/yr was estimated in terms of toxic pollutants released into different media (air, water, and land) whose intensities were available as shown in the following figure.

Figure 7 Ranking pollutant industries in percentage according to their participation total chemical toxic pollutants in air, water and land (see online version for colours)



Source: Data calculated by the author (Appendix – Table 6)

Manufacturing of basic chemicals contributed with 48.25%, and spinning and weaving with 16.54% and were the highest generators of toxic chemicals into water. Petroleum refiners contributed with 25.91%; manufacture of basic chemicals with 18.14% and non-ferrous metal basic industries with 10.5%, and were the highest air polluters. Manufacture of vegetable and animal oil has little contribution to air pollution. Petroleum refiners contributed with 37.61%, and manufacture of basic chemical with 21.6%, and they were the highest land polluters. Spinning weaving and finishing textile has the lowest contribution to land pollution.

2.4 Toxic metal pollution

The metal compounds used for estimating toxic metal pollution intensity were: aluminium (AL), vanadium (V), zinc (Zn) (fume or dust), antimony (Sb), barium (Ba), bromine (Be), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), magnesium (Mn), mercury (Hg), nickel (Ni), silver (Ag), and their compounds, thallium, thorium dioxide and titanium tetrachloride (Hettige et al., 1994).

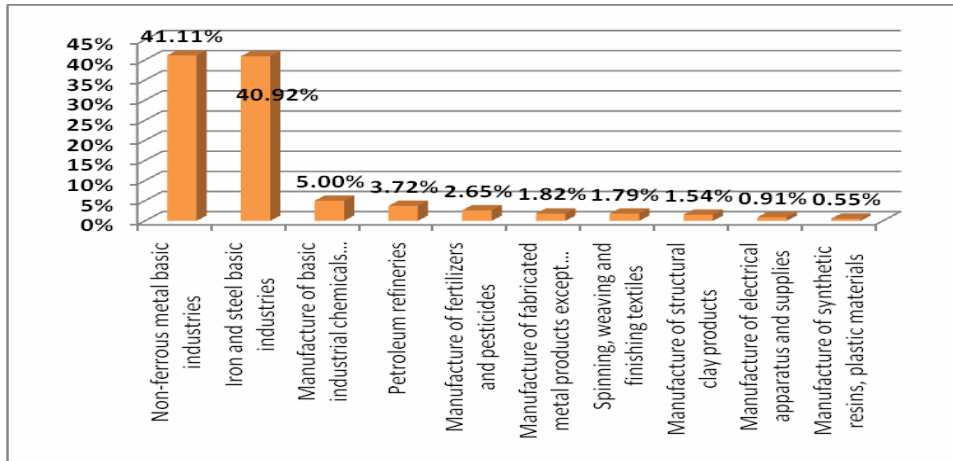
2.4.1 Ranking pollutant industries in percentage according to their participation total toxic metal pollutant

Non-ferrous metal basic industries contribute with 41.11%, and iron and steel basic industries with 40.92%, were the highest generator of total toxic metal. Manufacture of

technical electrical apparatus and supplies generate 0.91%, while synthetic resins sectors have negligible contribution around 0.55% from the total toxic metal emission.

These heavy metals from industrial processes can accumulate in nearby lakes and rivers. They are responsible for diseases to marine life such as fish and shellfish, and can affect the rest of the food chain. This means that entire animal communities can be negatively affected by this type of pollutant.

Figure 8 Ranking pollutant industries in percentage according to their participation total toxic metal pollutant (see online version for colours)



Source: Data calculated by the author (Appendix – Table 7)

All of this waste dumped into the sea could have an adverse effect on both marine organisms, and water quality. Some trace metals are essential for aquatic organisms (Fe, Mn, Cu, and Zn), but they are in toxic form when natural levels are exceeded to higher abnormal concentrations; other metals such as Pb and Cd are not essential and have a toxic effect (Bryan, 1976).

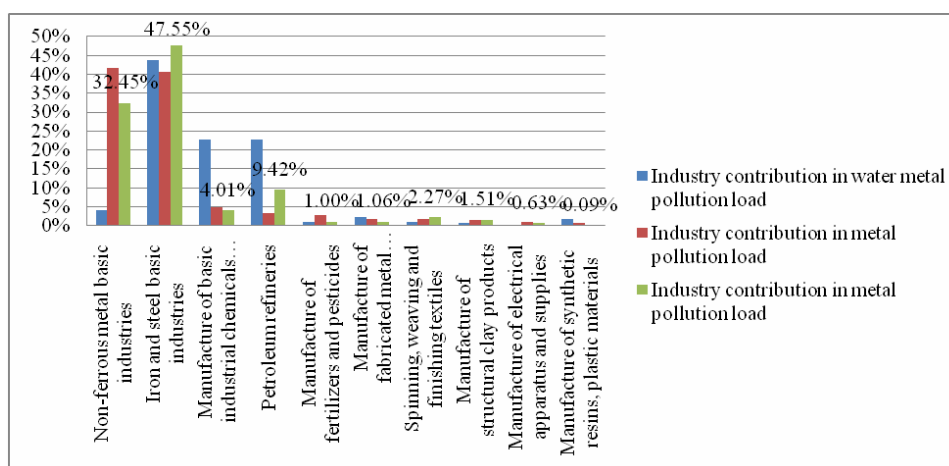
2.4.2 *Ranking pollutant industries in percentage according to their participation total toxic metal pollutant in air, water and land*

Iron and steel generate 43.79% from the total toxic metal pollutants in water, manufacture of basic chemicals account for 22.79% and petroleum refineries 22.68%, illustrating the highest ranking. Moreover, non-ferrous metal basic sectors generate 41.68%, and iron and steel 40.64%, and are the highest toxic metal polluters attributed to land pollution. However, manufactures of synthetic resins and electrical apparatus, have minimal contribution to land total toxic metal pollutants. Non-ferrous metal basic sectors generate 41.11%, and Iron and steel 40.92%, are the highest land polluters. Manufacture of synthetic resins and electrical apparatus has made little contribution to land pollution as shown in Figure 9.

From the previous estimation it has been determined that the major generator for environmental pollution, are the iron and steel industries, the cement industry and the petroleum refineries sector. Moreover, they were the main economic pillars, and attraction to employment. Iron and steel industries contribute to ca. 6.5% of the GDP, the cement

industry 3%, and the petroleum refiners sector 17% (UNIDO, 2009). This illustrates that an increase in allocation of resources toward pollution control, especially in these industries, is required.

Figure 9 Ranking pollutant industries in percentage according to their participation total toxic metal pollutant in air, water and land (see online version for colours)



Source: Data calculated by the author (Appendix – Table 7)

3 Pollution of River Nile and water poverty

Degradation of water quality presents a huge challenge that varies among different water bodies depending on: flow, use pattern, population density, industrial pollution, availability of sanitation systems, and social and economic conditions existing in the area of the water source. Discharge of untreated or partially treated industrial and domestic wastewater, the leaching of pesticides and residues of fertilisers; and navigation are often factors that affect the quality of water.

It is worth mentioning that agriculture has always been the core of the economic development of Egypt, and is considered to be the main activity for a large sector of the population. It contributes to over one fifth of the gross domestic income and consumes more than 85% of the available water resources. Municipal and industrial uses account for 15% of the total water consumption in the country, while river navigation and hydropower generation are considered as non-consumptive uses. Moreover, the majority of the population is concentrated in 4% of the total land area of Egypt; with the increasing pattern of population growth, which is expected to reach 95 million by 2025. A case, that creates a challenge for policy makers, because 98% of this population receives fresh water from the Nile River (Abu-Zeid, 2003).

All these challenges are in light of Law 48 of 1982, which specifically deals with discharges to water bodies. This law prohibits discharge to the river Nile, irrigation canals, drains, lakes and groundwater without a license issued by the Ministry of Water Resources and Irrigation (MWRI). Licenses can be issued as long as the effluents meet the standards of the laws. The license includes both the quantity and quality that is

permitted to be discharged. In Egypt, there are 25 agencies, and seven ministries are involved in water quality monitoring programmes. These supervising bodies lack intra- and inter-ministerial cooperation and data sharing. However, most of these monitoring activities are not conducted on a regular basis.

The Nile River is unfortunately polluted by industrial and agricultural waste and chemicals that find their way into the above and underground water sources. This major challenge facing Egypt is estimated to exaggerate, if we do not close the gap between the limited available water resources, and the increasing demand for water. This challenge is aggravated by the fact that the available water per capita, per annum amounts to around 900 m³, which is already below the 'water poverty' index of 1,000 m³/capita/annum. This figure is expected to fall to 670 m³ by 2017, unless policies are implemented to recognise water as human rights.

4 Potential impacts of water quality on the environment, health and the economy

4.1 Impacts of pollution on the environment

Although the water quality in the Nile is reasonable at present, locally water quality issues occur, caused by effluents from some larger urban areas and industries. Many drains are highly polluted and this poses a direct health threat, especially in – and around villages and towns in densely populated rural areas. If no additional measures are taken, the situation in the rural areas will deteriorate seriously in the future. Water quality will decline as a result of increasing pollution loads. This affects the user functions of the water system as well the health and the environmental conditions.

Moreover, the quality of ground water in the Nile system is generally still fairly good. However, in some shallow ground water bodies, pollution has reduced its suitability for raw drinking water. Especially in the fringes of the Nile valley and delta, where there is no protective clay cap, the ground water is highly vulnerable to pollution. If no measure is taken the ground water pollution will increase in the future. This poses a direct threat to public health since ground water is consumed without treatment.

Industrial waste consists of many toxic compounds that damage the health of aquatic animals and those who eat them. Some toxins affect the reproductive success of marine life, and can therefore disrupt the community structure of an aquatic environment. Suspended particles can often reduce the amount of sunlight penetrating the water, disrupting the growth of photosynthetic plants and micro-organisms. This consequently affects the rest of the aquatic community that depend on these organisms to survive

4.2 Impacts of pollution on health

Awareness has been growing about the dangers posed to human health and the environment by pollutants. Many of the substances of greatest concern are organic compounds characterised by persistence in the environment, resistance to degradation, and acute and chronic toxicity. In addition, many are subject to atmospheric, aquatic or biological transport over long distances, and are thus globally distributed, detectable even in areas where they have never been used. Chemical pollution of surface water can create health risks, because such waterways are often used directly as drinking water sources or

connected with shallow wells used for drinking water. The character of these substances cause them to be incorporated and accumulated in the tissues of living organisms leading to body burdens that pose potential risks of adverse health effects resulting in the following scenarios:

- spread of common vector, borne diseases such as malaria and dengue; as well as other major killers such as malnutrition and diarrhea
- health effects resulting from water shortage, high temperature, humidity and the increasing intensity of heat and cold waves
- an increase in mortality rates among children, and the elderly due to high temperatures.

Moreover, waterways play an important role for washing and cleaning, for fishing and fish farming, and for recreation. However, toxic chemicals such as arsenic and fluoride can be dissolved from the soil or rock layers into groundwater. Direct contamination can also occur from badly designed hazardous waste sites or from industrial sites.

This dilemma requires collaboration between the government, business and the individual to adopt regulatory measures to reduce the pollution levels from different sectors.

5 Protecting public health and environment

To determine which measures might improve the situation most effectively, the causes must be clearly addressed. However, these causes are institutional, pollution loads, or financial causes. Than packages of measures need to be selected that address the objectives, and they include:

5.1 Prevention measures to polluted industries

The emphasis is on the industrial and agricultural sectors to produce more and more environmental friendly products. However, it is not always attractive to industries to change to these new technologies, an issue that requires providing incentives to industries while encouraging the public to buy clean products. This can be done through generating funds for these actions, and by enhancing the supporting institution, through the following:

- Introducing financial incentives to promote clean industry products, by using taxes, tax exemptions, and subsidies for investment related to cleaner industrial processes and water recycling technologies.
- Compliance action plans or agreements for polluted industries to establish schedules for feasible improvements to water quality problems. Also, agreements can require periodic reporting of progress and sanitation on bad performance.
- Increasing public awareness campaigns to promote for the consumption of clean product in terms of water quality, an issue that requires people to be aware of the environmental impacts of the polluted products.

- Phase-out industries along vital inland waters and residential areas toward new industrial cities to decrease the pressure along the Nile valley.
- Introduce load-based discharge levies based on the polluter pays principle, these negative incentives related to the load of pollutants.
- Strengthening institutions control to enhance using resources efficiently

5.2 Treatment measures to industrial wastewater

Despite the implementation of the prevention measures, a large amount of waste water will still be produced by industries. A combination of measures is proposed to treat this load as follows.

- Treatment or pre-treatment of industrial waste water by industries themselves. This will ensure that the most appropriate technology for the particular type of waste is used, and all options for reuse are utilised.
- Separate collection of wastes and/or pre treatment of industrial waste water where it enables in many cases collection viable to recycle (e.g., engine oil).
- Introduce load-based discharge levies, as it acts as an incentive to encourage self treatment and a form of income to recover the cost of treatment if the government provides it.

5.3 Institutional measures on water quality

To support implementing strategy for water quality some general institutional measures must be adopted.

- Changing the role of the MWRI from operational to a controllable one.
- Coordinate investments on the regional and central to reuse, and efficient treatment for waste water. Mostly this will be at a regional or government level.

6 Conclusions

Industrial development projects that control the pollution of natural resources, particularly water supplies, will have a very large net positive economic impact, and it should be given a high priority. Moreover, more emphasis should be placed on the cost/benefit aspects of low-waste technologies and sensible legislation for environmental controlling should depend on the knowledge of the existing situation, and careful assessment of its impact on the development.

The industrial development problem in Egypt requires focusing on causes of different pollution and setting effective measures. The effectiveness of interventional measures would significantly reduce the overall pollution load, improving citizens' quality of life, and enhancing water poverty alleviation. This will never happen if industries or business activities keep producing polluted products, and consumers continue to demand it.

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Appendix**Table 1** Average annual real growth rates and structure of MVA at the two-digit level of ISIC – year 2000–2007

<i>ISIC description</i>	<i>ISIC</i>	<i>2000</i>	<i>2007</i>
Food and beverages	15	16.5385	7.8989
Tobacco products	16	0.0028	0.0019
Textiles	17	12.1201	6.5004
Wearing apparel, fur	18	4.148	5.3706
Leather, leather products and footwear	19	0.3674	0.0694
Wood products (excl. furniture)	20	0.3581	0.1368
Paper and paper products	21	1.384	1.6561
Printing and publishing	22	3.2585	6.298
Coke, refined petroleum products, nuclear fuel	23	4.182	12.9254
Chemicals and chemical products	24	21.2461	24.9651
Rubber and plastics products	25	2.3449	1.435
Non-metallic mineral products	26	10.5082	15.5736
Basic metals	27	6.8595	5.9411
Fabricated metal products	28	2.5023	2.4488
Machinery and equipment n.e.c.	29	4.8545	3.1151
Electrical machinery and apparatus	31	3.2675	3.106
Medical, precision and optical instruments	33	0.2273	0.1829
Motor vehicles, trailers, semi-trailers	34	4.9106	1.7876
Furniture, manufacturing n.e.c.	36	0.9197	0.5871

Source: UNIDO (2009)**Table 2** Relative importance of industry according to the employment during year 2002

Food, beverages, tobacco	21.89
Textile, Fabrics, leather	29.8
Manufacture of products of wood	0.5
Paper, publishing	4.05
Manufacture of refined petroleum products	3.18
Manufacture of basic chemicals, rubber product	10.5
Manufacture of non-metallic mineral products n.e.c.	8.08
Manufacture of structural metal products, tanks, reservoirs	6.08
Manufacture of general purpose machinery	3.33
Manufacture of office, accounting and computing machinery	3.79
Other manufacturing	8.76

Source: UNIDO (2009)

Table 3 Pollution load for each industry (pound/employee)

ISIC 2Digit	Metal pollution load			Poison chemical pollution load			Water pollution load		
	Met land	Met wat	Met air	Toxic land	Toxic wat	Toxic air	TSS	BOD	
31	121,700.8722	7,392.178	1,641.125	7,169,309.3	525,836.8	3,085,590	18,680,904.3	57,488,650	
32	978,870.9816	1,780,455	24,131.28	8,175,563	1,215,517	8,458,695	1,757,830.53	97,8324.4	
33	24,522.03429	36,67149	2,231.355	129,556.1	1,366.043	1,004,585	359,880.62	76,412.49	
34	26,489.36136	7,541,406	5,775.668	1,965,584.7	1,129,437	5,570,077	43,563,856.6	12,953,152	
35	7,542,640.791	210,798.9	247,917.3	17,762,5514	20,019,503	81,665,369	94,474,702.1	28,650,651	
36	619,108.583	1,045,385	89,545.04	4,612,772.1	80,342.03	3,350,625	22,830,625	150,583.9	
37	50,179,423.98	164,176	1,839,602	65,699,089	2,499,016	18,205,989	18,205,989	12,516,034	
38	1,742,541.953	7,653,491	73,720.38	6,698,459.2	178,280.4	9,147,240	9,147,240	117,822.5	
39	13,899,96761	71,6815	1,183.812	47,154,735	1,394,634	107,460.7	107,460.7	12,39804	

Table 3 Pollution load for each industry (pound/employee) (continued)

ISIC 2Digit	Air pollution load						
	PM ₁₀	VOC	NO ₂	SO ₂	CO	PT	
31	19,706,725	19,254,140	50,415,815	55,357,448	12,419,354	41,835,672	
32	428,816.1	10,839,895	20,111,977	16,287,067	2,872,508.9	3,726,315	
33	273,517.6	5,201,277.6	2,004,071.9	1,117,569.4	4,881,907.6	3,073,845	
34	1,353,554	6,622,350.2	13,351,423	24,158,351	27,646,981	4,733,249	
35	8,162,635	153,236,126	176,875,327	233,833,707	251,947,264	36,845,281	
36	9,702,909	562,625,208	81,069,387	126,662,612	16,202,995	91,687,407	
37	29,861,646	19,643,518	49,873,566	264,900,448	235,440,363	37,410,230	
38	172,249.8	13,023,913	3,965,552.2	5,766,029.1	6,778,550.2	1,402,014	
39	3,381,169	108,600.22	11,550,362	16,264.34	3,775,6504	9,338,591	

Table 4 Ranking industries according to air pollution

ISIC 4Digit	Industry	No. employee (thousand)	TSF	FP	VOC	CO	NO	SO	Total air pollution load	Industry % in pollution load
3530	Petroleum refineries	26	46,012,746	5,266,638	276,130,218	270,941,658	300,015,066	522,000,000	1,420,366,352	35.13%
3692	Manufacture of cement, lime and plaster	15.2	1.93 E + 08	332,171,558	1,055,974.4	22,576,909.6	185,484,870.4	399,000,000	1,133,495,662	28.03%
3710	Iron and steel basic industries	38.2	25,189,233	30,047,699.8	14,553,015.8	169,419,674	47,224,100.6	109,000,000	395,433,761.2	9.78%
3115	Manufacture of vegetable and animal oils and fats	18.2	95,802,307	58,795,518.6	25,622,615.2	7,474,558	33,476,770.6	93,524,686	314,696,473.2	7.78%
3720	Non-ferrous metal basic industries	17.5	11,023,915	1,205,995	4,775,207.5	61,059,092.5	4,275,372.5	131,000,000	213,339,600	5.28%
3691	Manufacture of structural clay products	28.5	55,477,188	11,305,152	5,742,351	16,788,324	70,673,217	7,314,297	167,300,557.5	4.14%
3211	Spinning, weaving and finishing textiles	181.1	7,353,347	1,100,001.4	15,554,860.1	7,609,822	56,702,410	41,095,031	129,415,652.2	3.20%
3511	Manufacture of basic industrial chemicals except fertilisers	9.4	5,541,685	1,169,190.8	20,015,861.8	19,784,095.4	25,615,545.2	34,485,752	106,612,140	2.64%
3118	Sugar factories and refineries	14.7	17,695,904	559,055.7	4,546,077.9	13,741,942.2	25,647,413.4	26,715,927	88,906,335	2.20%
3411	Manufacture of pulp, paper and paperboard	3.9	4,708,958	1,360,417.5	3,786,069.3	27,349,116.6	12,501,816.6	23,960,855	73,667,236.4	1.82%

Table 5 Ranking industries according to water pollution

ISIC 4Digit	Industry	No. employee (thousand)	TSS pollution load (pound/employee)	TSS pollution load (pound/employee)	Industry % in pollution load TSS	Bod lower-bound coefficient	Pollution load (pound/employee)	Industry % in pollution load BOD	Total water pollution load	Industry contribution % in total water pollution load
3710	Iron and steel basic industries	38.2	96,012,746	1,150,971,048	73.94%	2,105.4	80,426.28	0.11%	1,184,977,790	70.86%
3720	Non-ferrous metal basic industries	17.5	8,312,905	143,871,381	9.24%	575.085	10,063,993	13.91%	155,539,832	9.30%
3522	Manufacture of drugs and medicines	30.2	3,555,879	95,914,254	6.16%	14,183.2	4,283,332.6	5.92%	107,815,884.5	6.45%
3411	Manufacture of pulp, paper and paperboard	3.9	305,071.1	43,739,734	2.81%	3,302,138	12,878,337	17.79%	56,618,070.21	3.39%
3512	Manufacture of fertilisers and pesticides	15.7	3,054,594	47,957,127	3.08%	15,697.9	246,457	0.34%	48,203,584.4	2.88%
3530	Petroleum refineries	26	1,258,256	32,714,651	2.10%	250,712	6,518,522	9.01%	39,233,173.2	2.35%
3511	Manufacture of basic industrial chemicals except fertilisers	9.4	1,940,529	18,240,974	1.17%	1,255,449	11,801,219	16.31%	30,042,192.26	1.80%
3118	Sugar factories and refineries	14.7	863,752	12,697,147	0.82%	602,435	8,855,793	12.24%	21,552,940.08	1.29%
3112	Manufacture of dairy products	6.9	368,217	2,540,698	0.16%	2,556,411	17,639,236	24.37%	20,179,933.9	1.21%
3692	Manufacture of cement, lime and plaster	15.2	528,466	8,032,680	0.52%	241	3663.2	0.01%	8,036,343.6	0.48%

Table 6 Ranking pollutant industries according to chemical toxic pollutants

ISIC 4Digit	Industry	No. employee (thousand)	Water		Land		Air		Total toxic chemical pollution load (pound/employee)	Industry contribution % in total toxic chemical pollution load
			Water pollution load (pound/ employee)	Water industry contribution in pollution load	Pollution load (pound/ employee)	Land industry contribution in pollution load	Pollution load (pound/ employee)	Air industry contribution in pollution load		
3530	Petroleum refineries	26	1,887,756	10.29%	106,008,370	37.61%	25,033,710	25.91%	132,929,836	33.49%
3511	Manufacture of basic chemicals except fertilisers	9.4	8,854,518	48.25%	60,877,426.8	21.60%	17,526,196.6	18.14%	87,258,141.4	21.99%
3710	Iron and steel basic industries	38.2	2,130,605	11.61%	34,360,861.8	12.19%	5,994,382.2	6.20%	42,485,849	10.70%
3720	Non-ferrous metal basic industries	17.5	394,222.5	2.15%	26,903,747.5	9.54%	10,149,772.5	10.50%	37,447,742.5	9.44%
3512	Manufacture of fertilisers and pesticides	15.7	609,003	3.32%	175,955,86.6	6.24%	12,981,890.4	13.43%	31,186,480	7.86%
3522	Manufacture of drugs and medicines	30.2	393,234.2	2.14%	15,232,940.4	5.40%	10,177,188.6	10.53%	25,803,363.2	6.50%
3211	Spinning, weaving and finishing textiles	181.1	3,034,693	16.54%	5,535,140.4	1.96%	5,955,111.3	6.16%	14,525,125.5	3.66%
3513	Manufacture of synthetic, plastic and man-made fibres	4.8	527,035.2	2.87%	5,975,688	2.12%	7,208,246.4	7.46%	13,710,969.6	3.45%
3115	Manufacture of vegetable and animal oils and fats	18.2	520,720.3	2.84%	940,6943	3.34%	1,610,044.8	1.67%	11,537,708	2.91%

Table 7 Ranking pollutant industries according to toxic metal pollutant

ISIC 4Digit	Industry	No. employee (thousand)	Water		Land		Air		Total toxic chemical pollution load (pound/employee)	Industry contribution % in total toxic chemical pollution load
			Pollution load (pound/ employee)	Industry contribution in water metal pollution load	Pollution load (pound/ employee)	Industry contribution in metal pollution load	Pollution load (pound/ employee)	Industry contribution in metal pollution load		
3720	Non-ferrous metal basic industries	17.5	13,979.35	3.94%	23,265,203.7	41.68%	702,234,225	32.45%	23,981,417.43	41.11%
3710	Iron and steel basic industries	38.2	155,578.3	43.79%	22,687,383.4	40.64%	1,028,993.4	47.55%	23,871,954.7	40.92%
3511	Manufacture of basic industrial chemicals except fertilisers	9.4	80,567.87	22.68%	2,750,185.45	4.93%	86,741.7	4.01%	2,917,495.014	5.00%
3530	Petroleum refineries	26	80,865.98	22.76%	1,884,458.94	3.38%	203,840.52	9.42%	2,169,165.44	3.72%
3512	Manufacture of fertilisers and pesticides	15.7	3,747.12	1.05%	1,518,620.18	2.72%	21,744.34	1.00%	1,544,111.64	2.65%
3819	Manufacture of fabricated metal products except machinery and equipment	20.3	7,878.84	2.22%	1,029,925.58	1.85%	22,920.12	1.06%	1,060,724.53	1.82%
3211	Spinning, weaving and finishing textiles	181.1	3,308.7	0.93%	992,973.11	1.78%	49,069.05	2.27%	1,045,350.85	1.79%
3691	Manufacture of structural clay products	28.5	2,329.02	0.66%	863,642.34	1.55%	32,752.49	1.51%	898,724.13	1.54%
3839	Manufacture of electrical apparatus and supplies	1	486.1	0.14%	515,111.3	0.92%	13,585.3	0.63%	529,182.7	0.91%
3513	Manufacture of synthetic resins, plastic materials	4.8	6,511.58	1.83%	311,346.7	0.56%	1,999.58	0.09%	319,857.84	0.55%