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Full Length Research Paper

The preliminary study of urbanization, fossil fuels consumptions and CO_2 emission in Karachi

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According to population, Karachi is the first largest city of Pakistan and 9th largest in the world. During last three decades, it has faced mass urbanization, huge population growth, many fold increase in vehicles and industrial development. As a result the demand of more energy in form of fossil fuels increased for domestic, industrial and transportation purpose. In this research the maximum available data of Karachi about urbanization, population and vehicles growth, industrialization, energy consumption and CO_2 emissions are analyzed. Time periods considered for this work are according to the availability of the data. The results show that during 1947 to 2008, both urban population and urban area increased to 1500%. During 1990 to 2008, the percentage growth in vehicles is double than that of population growth during this time period. During 1980 to 2007 the consumption of oil and petrol, natural gas and coal increased to 219%, 365% and 287%, respectively. The emission of CO_2 jumped from 39 million metric tons in 1980 to 151 million metric tons in 2007.

Key words: Urbanization, fossil fuels, CO_2 emission, energy consumption, population growth.

INTRODUCTION

The 20th century witnessed the rapid urbanization throughout the world. The global proportion of urban population increased from 13% in 1900 to 29% in 1950 and, according to the 2005 Revision of World Urbanization Prospects, it has reached to 49% in 2005. Since the world is projected to continue to urbanize, 60% of the global population is expected to live in cities by 2030. According to the latest United Nations population projections, 4.9 billion people are expected to be urban dwellers in 2030 (Figure 1) which was 3.2 billion in 2005 (Population Division of United Nation, 2005).

Primarily the movement towards the cities was because of the application of new methods of cultivation that enabled a large production of food from small land, making a portion of the rural population surplus to go to towns to find opportunities for employment. Secondly the growth of commerce and industry in the towns and cities offered better opportunities of employment (Ahmed, 1965).

The present work focuses on Karachi, the provincial capital of Sind province of Pakistan. The census reports of Pakistan show that the urban population in Pakistan in 1951, 1961, 1972, 1981, 1998 was 17.8%, 22.5%, 25%, 28.3%, 32.5%, respectively and in 2008, it is estimated that urban population has reached up to 46% of total population of Pakistan (Population Association of Pakistan [PAP], 2009).

Karachi had an 3,640 km² area of and is located on the Arabian Sea coast in the extreme south of Pakistan (Figure 2). Its geographical co-ordinates are 24°45′N and 66°37′E. Topographically it can be divided into two major parts: the hilly areas in the north and west and an undulating plain and coastal area in the south-east. The hills in Karachi are the off-shoots of the Kirthar Range (mountain range located in Balochistan and Sindh

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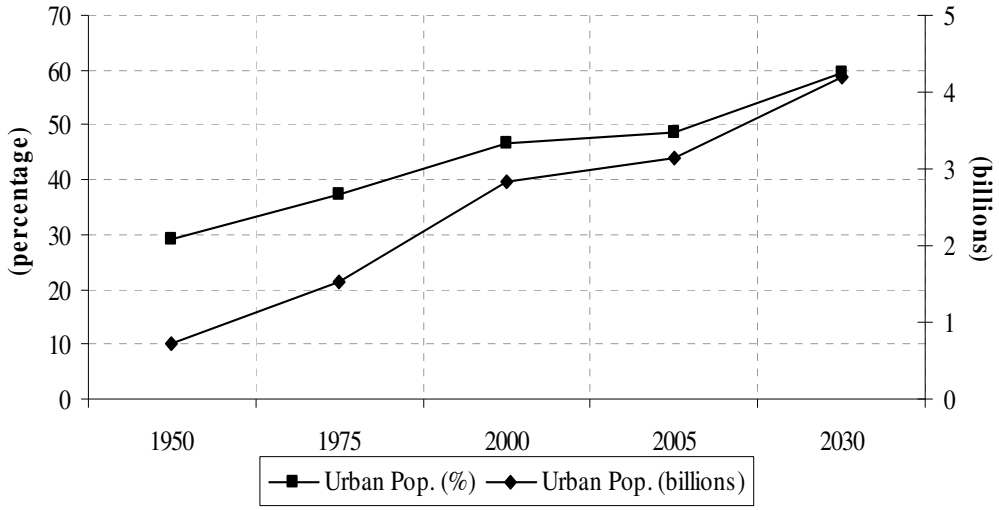

Figure 1. World urban population in percentage as well as in total since 1950 to 2030 (from Population Division of United Nation, 2005).

Figure 2. The location of Karachi on the political map of Pakistan. (Source of map: http://maps.google.fr/maps).

provinces of Pakistan which extends from north to southward for about 300 km). The highest point of these hills in Karachi is about 528m in the extreme north of the city. All these hills are devoid of vegetation and have wide intervening plains, dry river beds and water channels. Karachi has a long coastline in the south. Away from the shoreline are small islands including Shamsh Pir, Baba Bhit, Salehabad and Monora (the local names).

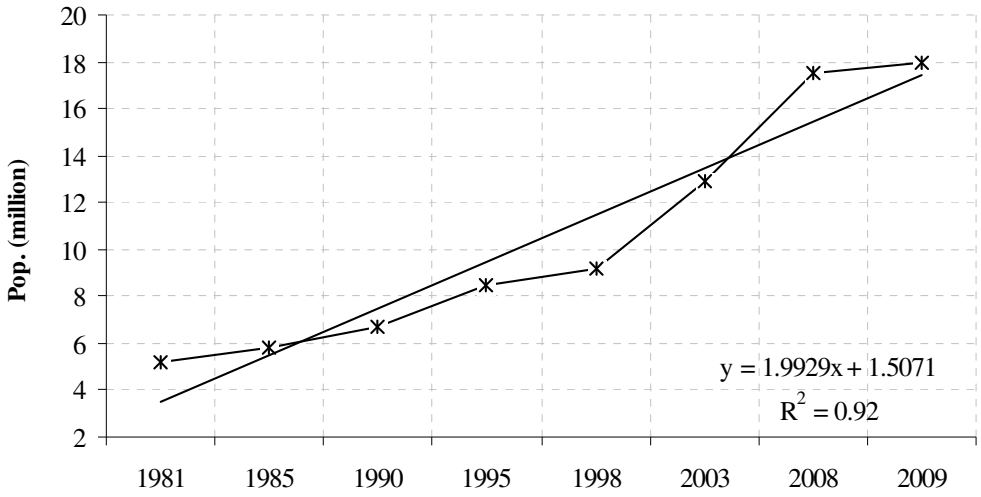

Figure 3. The growth and trend line of population of Karachi since 1981 to 2009.

Karachi has moderately temperate climate with a generally high relative humidity that varies from 58% in December (the driest month) to 85% in August (the wettest month). In winter, the average temperature of the city is about 21°C while in summer it reaches up to 35°C. Karachi receives about 256 mm of average annual rainfall (Hassan and Mohib, 2009).

Karachi is the financial and commercial capital of Pakistan. The major sea port of Pakistan is in Karachi. So it plays an important role in the economy of Pakistan and is considered as the economic and financial gateway of Pakistan. Karachi has several large industrial zones such as Karachi Export Processing Zone, SITE, Korangi, Northern Bypass Industrial Zone, Bin Qasim and North Karachi, located on the fringes of the main city (FPCCI, 2009). Its primary areas of industry are textiles, pharmaceuticals, steel, and auto-mobiles.

Karachi is now the largest city of Pakistan that has 18 millions of population. On the basis of population, it is the 9th largest city of the world (City District Government Karachi, 2009). Due to industrialization, business activities and excessive job facilities Karachi has been facing mass scale rural-urban migration from all over Pakistan.

The objective of this work is to study the increase in energy consumption and emission of CO_2 in Karachi in response of this urbanization and population growth during 1947-2008.

In part two of this work, we present data and methodology. Results and discussion are given in part three. Conclusion is given in part four of this work.

DATA AND METHODOLOGY

To study the urbanization, energy consumption and CO_2 emission in Karachi, we have analyzed different kinds of data by using linear regression that made us able to understand the urbanization evolution and its effects on the demand of the energy consumption and CO_2 emission. The following data is analyzed (i) world urban population as total and in percentage from 1950 to 2030 (Population Division of United Nation 2005); (ii) urban population of Karachi from 1981 to 2009 (CDG Karachi, 2009); (iii) industrial units and industrial area from 1947-2009 (FPCCI, 2009 except data from 1986 to 2009); population and vehicles growth from 1990 to 2002 (Qureshi and Huapu, 2007; Linden, 1993) and from 2003 to 2008. Karachi has 10% of the total population of the country. It is the largest city of Pakistan and is the Industrial, trade and transportation hub of the country. Thus it is also the major consumer of energy. It is assumed here that it consumes 12~15% of the total energy consumption in Pakistan. We have analyzed the data of the consumption of oil and petrol and natural gas (15% of total consumption of pakistan), coal (12% of total consumption of pakistan) and emission of CO_2 (15% of the total emission of pakistan) in Karachi from 1980 to 2006. Total per-capita energy consumption in Pakistan is 12.4 million BTUs (Energy Information Administration, 2008).

RESULTS AND DISCUSSION

Urban population and area

As many cities in the world, Karachi has expanded rapidly. Due to the mass rural-urban migration an important urbanization period in Karachi is seen after 1980s.

Figure 3 is describing the population growth with trend line since 1981 to 2009. According to the Pakistan census reports, in 1951, the population of Karachi was just 1.1 millions, in 1981, it grown up to 5.2 millions in

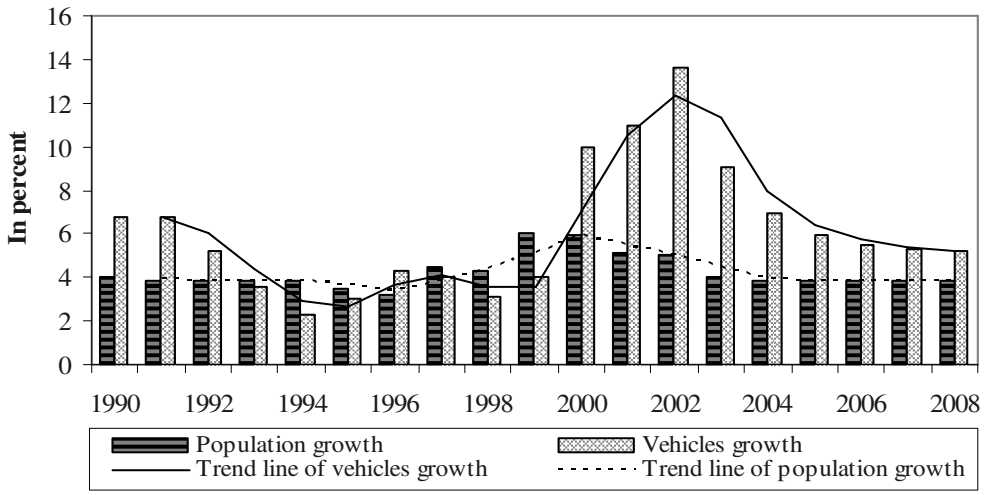

Figure 4. Growth in registered vehicles and urban population (in percentage). (Data source: Qureshi and Huapu, 2007 and Urban Resource Centre, Karachi).

2008, it reached to 18 millions. So since the independence of Pakistan in 1947 to 2008, the increase in population is about 1,500% and the rate of rapid growth in urban population is observed after 1998. To fulfill the residential requirements for the increasing number of people in the city, new towns, housing societies and industrial zones were established at open spaces within the city and in suburbs. The area of Karachi in 1947 was 233 km^2 and in 2008, area of Karachi is measured 3,640 km^2.

Table 1. Number of registered vehicles in Karachi; period 2002-2007.

Year	Number of vehicles (.10^3)
2002	1113
2003	2290
2004	3570
2005	5001
2006	6611
2007	8420

Source: Urban resource centre.

Transportation

The transport sector in Karachi had been developing with population growth and rapid urbanization. But unfortunately, Karachi has still poor transportation system as compare to the transport system of other mega cities of the world. In the modern era of technology and development, the city of 18 millions of population still has no tram or subway system to fulfill the transport facilities of the residents of Karachi. Total length of road network in Karachi is over 8,000 km with a density of 219 km per 100 km^2.

Figure 4 is showing the growth rate of vehicles and urban population. During 1990 to 2008, the observed growth in vehicles is comparatively greater than the population growth. The maximum difference between population and vehicles growth is measured from 2000 to 2008. During this time period, the trends of the both are contrary to each other in which population growth has decline while vehicles growth boosted up to 14% annually. This was due to increasing demand of transportation in the city and the public and private banks in Pakistan which offered loan policies with low interest rate for the vehicles. Moreover, it was prime time for the automobile industry and financial support in term of easy loans from the banks made it possible for people to buy their own vehicles.

According to Qureshi and Huapu (2007) and Khan (2007), in 2003, there were 50% cars, 42% motorcycles, 3% taxis, 3% auto rickshaws and 2% buses and minibuses (92% of private vehicles and 8% of public vehicles).

Table 1 is showing that there were 1,113,000 registered vehicles in Karachi in 2002 and 8,420,000 registered vehicles in 2007. During this short time period, we saw the regular growth in vehicles. The observed growth during this time period is about 656% and it is many time more that the growth in urban population.

Fossil fuels consumption

The demand of fossil fuels in Karachi increased many folds than before. It is mainly due to the above stated reasons of increasing population, vehicles growth and Industrial development. The demand of petroleum products,

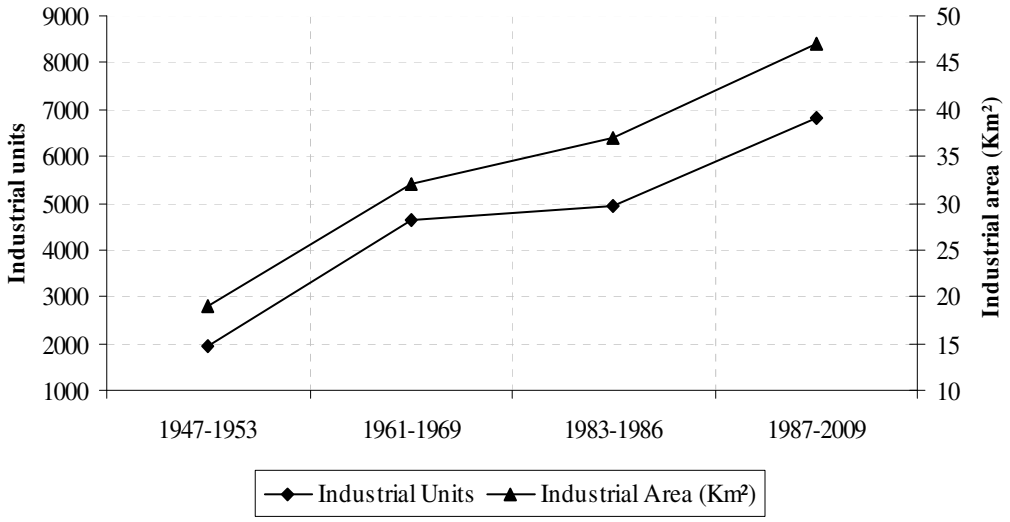

Figure 5. The growth in industrial units and Industrial area in Karachi since 1947 to 2009.

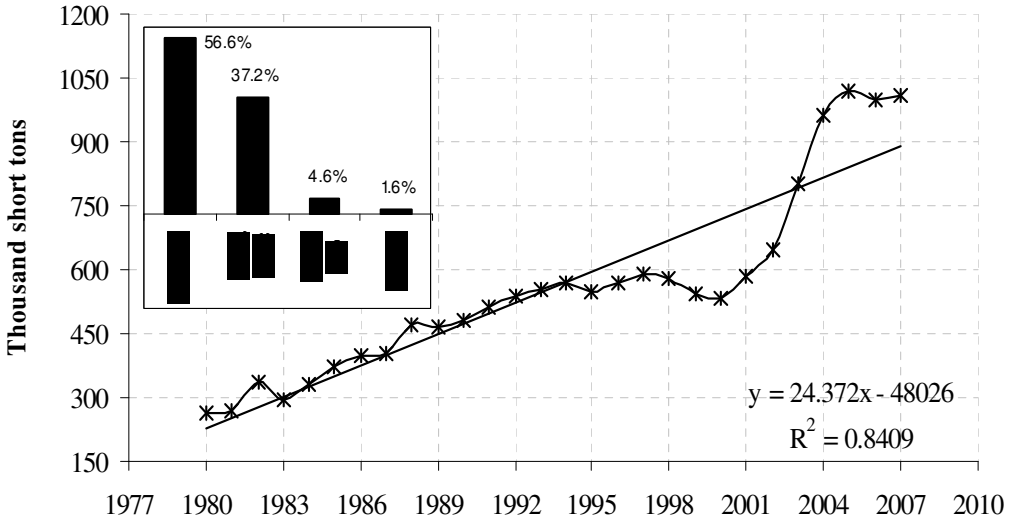

Figure 6. The evolution and trend of consumption of coal in Karachi since 1980 to 2007. Histogram is showing sector wise consumption of coal in Pakistan in percentage for the year of 2007-08. Histogram data source: Sheikh (2010).

natural gas, electricity and coal in Karachi has been increasing with time.

Figure 5 is presenting the growth in industrial area and industrial units. It is seen in this figure that the major industrial development in Karachi was during 1947 to 1969 and during 1986 to 2009. The high growth rate in urban population and urbanization is also observed during in the era of industrialization. The computed growths in industrial units and industrial area in the above figure are 249% and 147%, respectively. It clearly shows that the proportion of increasing trends between industrial units and area is not uniform and the industrial zones became denser with time.

Figure 6 is showing that consumption of coal in 1980 was 262,000 short tons that increased to 1,009,000 short tons in 2007 with an increase of 285%. During 1993 to 2000, the coal consumption was quite stable but during 2000 to 2006 increased a lot. This rapid increase is mainly due to increase of consumption of coal in cement industry that is one of the most important industry in Karachi. Sheikh (2010) reported in his work that in fiscal year 2002-03, the consumption of coal in cement industry and brick kilns in Pakistan was 19.6% and 53.3%, respectively and the percentages in the fiscal year 2007-08 was changed to 56.6% and 37.2%, respectively.

Figure 7 is highlighting the consumption of oil and petrol in Karachi. The per day consumption of oil and petrol jumped from 16,000 barrels in 1980 to 51,000

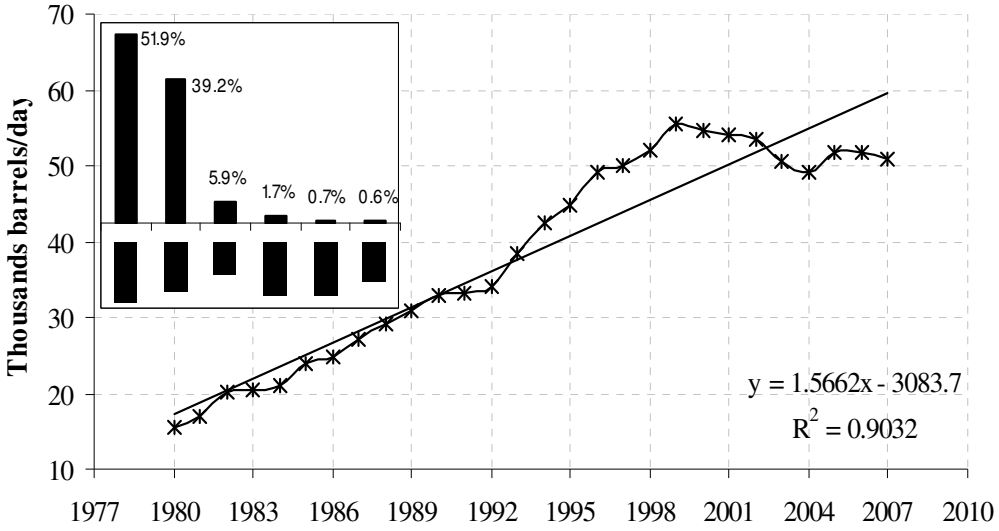

Figure 7. As figure 6 but for consumption of oil and petrol.

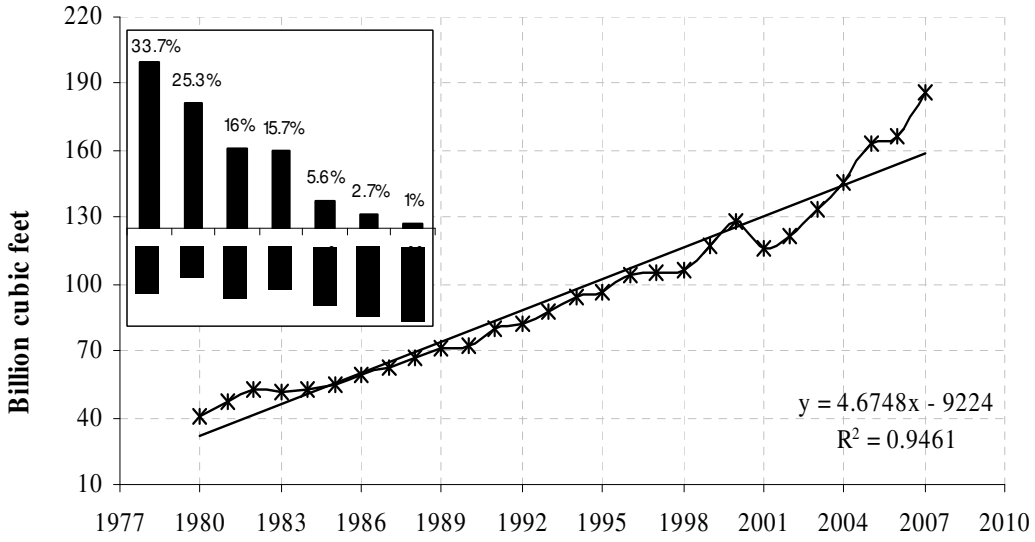

Figure 8. As figure 6 but for consumption of natural gas.

barrels in 2007 with an increase of 219%. This oil and petrol are mainly used in transport and power sectors (Sheikh, 2010). After 1993, along with the transport sector, the consumption of oil increased mainly due to usage of oil in thermal power stations which were established just after 1992 (Pakistan, 1994). After 2001, thousands of the old diesel engine vehicles were replaced by the compressed natural gas (CNG) engines.

Figure 8 is elaborating the consumption of natural gas that increased from 40 billion cubic feet in 1980 to 186 billion cubic feet with an increase of 365%. Its consumption has been regularly increasing with time. It is mainly consumed in power generation, industries and houses. Its consumption in transport sector is vibrantly increasing with time.

CO_2 emission

According to report of University College London workshop on climate change (2005), eleven of the world's global cities are responsible for some 70% of CO_2 emissions. Although Karachi is not including among these eleven cities but the rising trends of increasing emission of CO_2 are significantly showing that it will be one of the major cities who have maximum emission of CO_2. Total per-capita energy consumption in Pakistan is 12.4 million BTUs (1 BTUs = 1,055.055 joules) that contributes 0.7 metric tons per-capita energy related CO_2 emission in environment.

Figure 9 is showing the regular increase of CO_2 emission in atmosphere over Karachi. The rate of emission

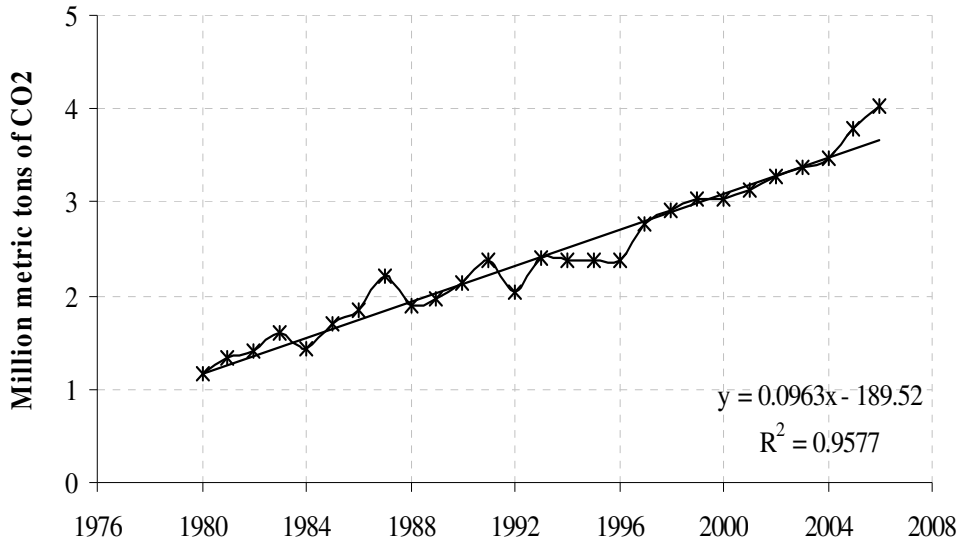

Figure 9. The emission of CO_2 from consumption of fossil fuels in Karachi (million metric tons of CO_2) since 1980 to 2007.

of CO_2 is not only rapid but it is showing a regular and positive trend without any significant down fall throughout the computed time. It is observed that the CO_2 emission in atmosphere has reached up to 151 million metric tons in 2006 that was just 39 million metric tons in 1980. This 287% increase in CO_2 during 1980 to 2007 is the result of mass urbanization and energy consumption in Karachi.

Conclusion

In this research, we analyzed data to show the rapid urbanization, industrialization and population and vehicles growth which played a critical role in the consumption of fossil fuels in Karachi during 1947 to 2008.

In the results sections, the computed data of Karachi's population, growth in population, vehicles, industrial area and industrial units showed a greater correlation among one an other. We showed that both urban population and urban area increased to 1500%. During 1990 to 2008, the percentage growth in vehicles is double than that of population growth during this time period. During 1980 to 2007 the consumption of oil and petrol, natural gas and coal increased to 219%, 365% and 287%, respectively. The emission of CO_2 jumped from 39 million metric tons in 1980 to 151 million metric tons in 2007.

Many strategies can be adopted and measures can be taken by the local, provincial and federal government to save the huge amount consumed in term of utilization of oil, petrol and imports of vehicles and their parts. The energy consumption and CO_2 emission can be reduced many folds by managing sustainable urban development through (i) developing of efficient urban transport system (ii) starting the subway tram system like other mega cities of the world (Seoul, Paris, New York, etc.); (iii) using alternative energy resources as solar energy, wind energy and biofuels. It will help to reduce at least 40% of the consumption of fossil fuels and CO_2 emission and will be helpful to save large amount of national capital.

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REFERENCES

Ahmed KS (1965). Urban Population in Pakistan: Pakistan Geographical Review, Vol.x (1): 1-18.

City District Government Karachi (CDGK) Pakistan (2009). URL accessed on October 17, 2009. http://www.karachicity.gov.pk/

Energy Information Administration (2008). Official energy statistics from the US Government, URL accessed on November 23, 2008. http://tonto.eia.doe.gov/country/country_energy_data.cfm?fips=PK

FPCCI (Federation of Pakistan Chambers of Commerce & Industry), (2009). Industrial Zones in Pakistan. Website accessed on December 20, 2009. http://www.fpcci.com.pk/

Hassan A, Mohib M (2009). The case of Karachi, Pakistan. Website accessed on December 22, 2009. http://www.scribd.com/doc/270519/The-Case-of-Karachi-by-Arif-Hasan

Khan WA (2007). Total number of vehicles in Karachi up to 2007: A presentation at Urban Resource Centre, Karachi. Data accessed on December 21, 2009. http://www.urckarachi.org/No.%20of%20Vehicle%20till%202007.HTM

Linden E (1993). Megacities, TIME magazine in partnership with CNN. http://www.time.com/time/magazine/article/0,9171,977445-4,00.html

Pakistan: A country study (1994) Pakistan Economy and Energy. Website accessed on March 23, 2010. http://www.country-data.com/cgi-bin/query/r-9842.html

Population Association of Pakistan (2008). Website accessed on November 12, 2008 (http://www.pap.org.pk).

Population Division of United Nation Department of Economic and Social Affairs (2005). World urbanization prospects: The 2005 Revision (2005). Website accessed on April 26, 2009. http://www.un.org/esa/population/publications/WUP2005/2005wup.htm.

Qureshi IA, Huapu L (2007). Urban transport and sustainable transportation strategies: a case study of Karachi, Pakistan. Tsinghua Science and Technology 12, 309–317.

Sheikh MA (2010) Energy and renewable energy scenario of Pakistan. Sustainable renewable and sustainable Energy Review, 14: 354-363.

University College London Workshop (2005). Climate Change and Urban Areas: 11-12 April 2005, University College London Environment Institute Report: pp. 1-28.