Demography India ISSN: 0970-454X
Special Issue (2017), pp: 61-68

An Index Based Comparison of Environmental & Demographic Condition of SAARC Countries

Tapan K. Roy
Md. Aminur Rahman
Md. Abdul Kaium
Brijesh P. Singh

Abstract

The large cities consume more resources in SAARC region than small ones but consumption patterns of resources and technology choices may account for more environmental harms than the sheer numbers of people. The study based on the most recent data base made by World Bank GEO data which is maintained by Global Data Center, United Nations Environment Program. In this study, an attempt has been made to show the position and rank of SAARC countries such as India, Bangladesh, Sri Lanka, Pakistan, Bhutan, Nepal, and Maldives in terms of demographic and environmental indicators. For this purpose, the indices have been constructed by using demographic and environmental variables such as population, proportion of population aged 15-64 years, affluence, technology, carbon dioxide ($C0_2$) emission, urbanization and energy intensity. Carbon dioxide ($C0_2$) emission is considered the main culprit of environmental degradation. The other indicators like population, growth of technology are also considered deterioration of environmental quality. The index value and ranking position leads to a conclusion that anthropogenic carbon dioxide emissions in SAARC countries are increasing and has more than double from its normal level and it is continuing to increase until the present. Investing in less energy intensive technology can change the current direction of CO_2 emissions. It needs cooperation and commitment among each country in SAARC region to improve the environmental condition.

Introduction

Over the last decades, population is growing at an alarming rate in developing countries in the world as well as in South Asian Association for Regional Cooperation (SAARC) countries. World population grew from 1.6 billion to 7 billion during 1900 to 2011 and in SAARC countries population grew from 1.2 billion to1.8 billion during the years 1991 to 2011 (Kohler, 2012). The growing population has increased demand for their basic needs of food, energy, water, health care, sanitation, housing and so on. In order to improve the quality of life, the utilization of resources has speeded up, which coupled with tenure insecurity or the absence of clear property rights, has resulted in the over exploitation of natural resources (Goldstone, 2010). The more people require more food and shelter; then it is needed more land for irrigation and settlement (Ehrlich & Holdren, 1971). Thus, to feed the growing population and their settlement the large tracts of forested land are destroyed. As a result of increasing population growth, the water demand is increasing for irrigation and industrial uses are also growing. The above facts directly and indirectly pressures on environment and climate.

The population growth will cause an increase in the number of consumers, because there are more people to feed, clothe, transport and so on. However, the effect of increase in population will not necessarily lead to change in demographic pattern (Shi, 2003) but also affects on environment and other patterns through various indirect mechanisms, as each extra set of births will change the social, economic and technical conditions of the country. Such population growth observed can increase energy use per person if changes in lifestyle habits also occur (Barlow, 1994). It can be explained that population growth has been postulated as being in a relationship with economic growth (either increasing or decreasing GDP per capita). In turn, economic growth has been said to either be: heavily linked to change in demographic pattern, become delinked, or even change in demographic pattern after a certain level of GDP per capita is reached. In a study, it is observed that population growth has a disproportionately large effect on demographic changes as “multipliers” (Satterthwaite, 2009).

First, if population continues to grow, it will run out of those natural resources that are non-renewable and easy to source. In turn, this can lead countries to switch to materials that are less accessible and may have a higher environmental impact. In this connection, once natural gas runs out, coal will be increasingly used for power generation and heating (Bose, 2010). In a study, Asafu-Adjaye (2000) also finds that in one of his models in growth in population increases energy consumption, stating “societies may become more energy intensive, all else being equal, as their populations become large (or less intensive as their populations decline)”. Another study, York et al.

(2003) suggests various reasons for this, including different settlement patterns that emerge, lack of planning and the need for building more infrastructures. Finally, it is clear that over population causes dramatically change in demographic pattern in developing countries like SAARC regional countries.

Economic growth is mainly affected by the population explosion, because the more the human activities the more driven economy will be and this in-turn brings the needed growth in the economy (Goldstone, 2010). For instance, many rural people come in urban areas which has little or no economic problem compared to urban, semi urban area that have more population as a result urbanization has occurred. The efforts of governments in the developing countries to feed their peoples and also provide quality social services for them are being frustrated by rapid urban population growth (Stern et al., 1996). Development is the enormous expansion in the global production of goods and services driven by technological, social and economic changes has allowed the world to sustain much larger populations and vastly higher standards of living than ever before in the past. From 1900 to 2000, world real Gross Domestic Product (GDP) increased 20 to 40 times, while world population increased close to 4 times(Lutz & Samir, 2010).

Relatively rapid and uneven population growth and economic development are also occurring simultaneously with the degradation of aspects of the earth's physical environment. About 60 percent of the world population lives within 100 kilometers of the coastline, and more than 3 billion people rely in some manner on coastal and marine habitats for food, building sites, transportation, recreation, and waste disposal. Around one third of the world's coastal regions are at high risk of degradation, particularly from land-based sources of pollution and infrastructure development (Stern et al., 1996).

A proxy indicator of environmental degradation, Carbon dioxide (CO_2) emission trend is increasing day by day due to rapid population growth in various countries. CO_2 emission is considered the main culprit of global warming and it causes adverse effect on our environment (Shi, 2003). The higher concentration of carbon dioxide in the atmosphere is likely to increase the temperature of the atmosphere. It permits the short wavelength visible radiations to pass through it but traps the longer wavelength infra-red radiations (heat waves) reflected by the earth's surface. This trapping of heat waves causes excessive heating of earth's atmosphere. This heating effect on earth produced in this way is called Green House Effect (Samimi & Zarinabadi, 2012). Due to the excessive heating of earth become gradually hot the climate and its atmosphere have adverse effect on our climate, which will affect all the living beings. The climate will become gradually hot. Estimate suggests that the average temperature of the earth has increased by 1^0 C in the last 50 years (Meinshausen et al., 2009).

It is predicted that if the global temperature rises by 3.6^0 C, the polar ice caps and glaciers would melt. This would increase the water level of oceans by about 100 m and hence lead to the flooding of low-lying coastal areas of the earth (Titus et al., 1991). SAARC countries will be also affected by such green house effects. It is found that the global CO_2 increased by 3 percent in 2011, reaching all time high of 34 billion tones in 2011. CO_2 concentrations in the atmosphere have been increasing over the past century compared to the rather steady level evident during the pre-industrial era (about 280 per million in volume, or ppmv). The impacts of the increased CO_2 concentrations change the characteristic of the interacting climate, ecological and socio-economic systems (Moss et al., 2010). In SAARC countries CO_2 concentrations are increased by 5.14 metric tons during the year 1991 to 2011(Book, 2011).

In environmental context, evidence suggests the large cites consume more resources than the small ones but consumption patterns and technology choices may account for more environmental harms than sheer numbers of people. Among SAARC countries, the Indian population is about 9 times as large as that of any country, but India currently uses for more energy because Indians are more affluent and use their wealth to buy energy ― intensity goods like cars and electronics (Apergis & Tang, 2013). Any rich and powerful country becomes environmental threat for a neighboring poor countries Population, GDP, urbanization, energy use, and greenhouse gas (carbon dioxide) effects are becoming extremely significant which exceeds the normal extent fits the SAARC countries (Mudakkar et al., 2013). Due to the rapid development of the economics, the emission of carbon dioxide grew up steadily over the last few decades, which is considered to be the crucial factor of greenhouse effect.

In the above background, this study is an attempt to realize the environmental and demographic situation in the SAARC region by constructing an index. . It also shows the position and rank of SAARC countries in terms of demographic and environmental indicators by using an index.

This study will help researchers and policy makers in the field of environment to take various environmental related policies

Data and Methods

The study based on the most recent data base taken up by the World Bank Data source in 2011. This data are maintained by Global Data Center, United Nations Environment Programme (UNEP) by Global Environmental Outlook (GEO) project. These data are known as GEO data.
The World Bank Data Portal is the authoritative source for data sets used by World Bank and its integrated environment assessments. The data sets hold in the environmental and demographic related data portal are derived from many different organizations and uses both primary data sources such as Food and agriculture Organization, United Nation Population Division, as well as global and regional data compilations such as the World Resource Institute. The present uses mainly the demographic and environment related data of World Bank 2011. This source of data is officially published by successive year.

In this study, an attempt has been made to construct an index designed to measure the performance and environmental situation of SAARC countries. This index includes population, proportion of population aged 15-64, affluence, technology, carbon dioxide ($C0_2$) emission, urbanization, energy intensity, urbanization and technology. For this index, among all indicators, carbon dioxide ($C0_2$) emission is considered main culprit of environmental degradation. The other indicators like population, growth of technology are also considered deterioration of environmental quality. As results, such countries are facing a number of different environmental crises such as deforestation, desertification, soil erosion, destruction of wetlands and inland fisheries, inland salinity intrusion, loss of biodiversity and natural resource depletion. Furthermore, natural disasters like floods, cyclones, tidal surges and tornadoes have resulted in severe socioeconomic and environmental damage. The index is constructed in the following ways. Let X_{ij} denotes value of i^{th} variable for j^{th} country. We may get an index called the single variable index at the country level by using the following formula:

$$IE_{ij} = \frac{(X_{ij}) - Min(X_{ij})}{Max(X_{ij}) - Min(X_{ij})} \times 100$$

where, Max (X_{ij}), Min (X_{ij}), and (X_{ij}) are the maximum, minimum, and actual value of X over the countries respectively. For example, Bangladesh (j is then Bangladesh), the population index (population size is then indicated by i) is obtained by dividing the subtracting result of actual value from maximum value by the subtracting result of minimum value from maximum value and then multiplied by 100. According to this formula, the highest index value considered the top ranking position. If the population of Bangladesh is 131.1 million and minimum value of the number of population is 0.179 million and maximum value is 1300.0 million. So the value of population index for Bangladesh is as follows:

$$\text{Population Index} = \frac{131.1 - 0.179}{1300.0 - 0.179} \times 100 = 10.07$$

Results and Discussion

It is note that there are various complexity factors that drive environmental condition. Evidence continues to accumulate suggesting that much of the change in atmospheric gas concentrations is human-induced. In human societies enjoy and utilize the environment for the fulfillment of their basic needs (food clothing, shelter, etc.) and wants (luxury items, social prestige based e.g. on economic status etc.), humans have a vested interest in a healthy and productive environment (Shi, 2003). It is to identify the ranking position of each country among SAARC on the basis of environmental condition measuring by different index depends on population, CO_2 emission and so on.

Index of Population Growth

Population size and its growth has been one of the main factors in causing carbon dioxide (CO_2) emissions because the two seem to go hand-in-hand. If the affluence and technology held

constant, the economic activity is required to support an additional person means more resources must be extracted and more emissions are generated. The Index of population growth on environmental problems is specified through two mechanisms; (i) a larger population could result in increased demand for energy for power, industry, and transportation, hence the increasing fossil fuel emissions, (ii) population growth can contribute to greenhouse gas emissions through its effect on deforestation. An increase in population causes greater deforestation, land use changes and more consumption of wood for fuel; thus, larger population raises CO_2 emissions and contributes to the greenhouse effect (Birdsall, 1992). In this context, Shi (2003) argued that one percent of population growth is associated with a 1.28 percentage increase in emissions on average. From table 1, it is observed that India comes to the top of index of population ranking. The second, third, fourth and seventh countries are Pakistan, Bangladesh, Nepal and Bhutan respectively. It may be noted that the total population of India is comparatively higher than other SAARC countries, so their environmental change occur so fast. The ranking position of Pakistan and Bangladesh second and third so their climate also changes.

Table 1: Construction of population index among SAARC countries

SAARC Countries	IP	IP%	Rank
Bangladesh	0.12227	12.227	3
Bhutan	0	0	7
India	1	100	1
Maldives	0.00020	0.020	6
Nepal	0.02330	0.023	5
Pakistan	0.13683	13.683	2
Sri Lanka	0.00178	0.178	4

Note: IP=Index of Population

Index of the Percentage Population Aged 15-64

The effect of population on the CO_2 emissions is great, especially the percentage of population aged 15 to 64, and its effect is positive at low income levels supports the Malthusian perspective, which holds that population growth increases CO_2 emissions. With the increases in the percentage of population aged 15 to 64, CO_2 emissions increases, it reduces when income per capita reaches higher level. SAARC countries are low income countries with the increases in the percentage of population aged 15−64, CO_2 emissions relatively increase, as a result, environmental condition changes.

Table 2: Construction of Percentage Population aged 15-64 index among SAARC countries

SAARC Countries	IPP	IPP%	Rank
Bangladesh	0.88470	88.470	3
Bhutan	0.86744	86.744	4
India	0.92189	92.189	2
Maldives	0.86371	86.371	5
Nepal	0.83523	83.523	6
Pakistan	0	0	7
Sri Lanka	1	100	1

Note: IPP=Index of the percentage population aged 15-64

From table 2, it is observed that Sri Lanka takes the top ranking position of IPP 15-64. Because of lower middle income country Sri Lanka to raise their income levels for meeting up economic demand for their growing population. Consequently, their demand for energy for power, industry and transportation are increased, hence increasing fissile fuel emissions. India, Bangladesh, Bhutan are also responsible for their top ranking position.

Index of CO_2 Emissions

There is overarching consensus in the scientific community that the accumulation of greenhouse gases (GHGs) in the atmosphere is a primary contributor to the observed rise in global

surface temperature (IPCC 2007). The combustion of fossil fuels explains the increase and accumulation of GHGs in the Earth's atmosphere. Carbon dioxide (CO_2) is the main GHG responsible for global warming and related changes in climate. CO_2 is at its highest level in 420,000 years at approximately 380 parts per million (PPM). Since the dawn of the Industrial Revolution in the mid-eighteenth century, the concentration of CO_2 in the Earth's atmosphere has risen approximately 30% (Vitousek et al. 1997). The carbon cycle owes this vast increase to CO_2 emissions from energy usage, automotive transit, and mass production and consumption activities. In this study, CO_2 emission is measured by Metric tons .The lower position of the ranking number among the SAARC countries indicate the higher is the efficiency of economy and therefore much degradation of environmental condition. From table 3, it is observed that India sited on the top ranking position so that India much responsible for CO_2 emissions. Comparing these table it is seen that the ranking position of the rest of the SAARC countries almost same.

Table 3: Construction of CO_2 emission index among SAARC countries

SAARC Countries	ICE	ICE%	Rank
Bangladesh	0.06677	6.677	5
Bhutan	0.19517	19.517	3
India	1	100	1
Maldives	0.15973	15.973	4
Nepal	0	0	7
Pakistan	0.48433	48.433	2
Sri Lanka	0.02876	2.876	6

Note: ICE = Index of CO_2 emissions (Metric tons)

Index of Affluence

Affluence denotes the per-capita level of goods and services produced in a country in a given time period, measured by Gross National Product (GNP) or Gross Domestic Product (GDP) per capita. Affluence in this study is measured by GDP per capita (constant 2005 US$). Affluence is a critical determinant of environmental degradation because high rates of economic activity are associated with rapid rates of resource use and waste production. In general, increasing development tends to exacerbate environmental impacts.

Table 4: Construction of Affluence index among SAARC countries

SAARC Countries	IA	IA%	Rank
Bangladesh	0.06619	6.619	6
Bhutan	0.24190	24.190	3
India	0.10952	10.952	5
Maldives	1	100	1
Nepal	0	0	7
Pakistan	0.12507	12.507	4
Sri Lanka	0.26541	26.541	2

Note: IA=Index of Affluence using GDP per capita (constant 2005 US$)

It shows that economic growth is responsible for most of the changes in CO_2 emission. Regarding decreasing affluence, the main issue is that there would be no single country that accepts reducing their economic growth. From table 4, it is observed that Maldives takes the top ranking position of affluence so in this angle of vision Maldives stands on more vulnerable situation than other SAARC countries. It is seen that the ranking position of Bangladesh is five and six so in this view point environmental condition of Bangladesh roughly good.

Index of Energy Intensity

The effect of energy intensity is greatest for the lower-middle countries, and is similar for other levels. Because of the high investment, maintenance costs and long R and D cycles of technologies, the improvement of energy efficiency is relatively slow (Y. Fan et al, 2006).

Table 5: Construction of energy intensity index among SAARC countries

SAARC Countries	IEI	IEI %	Rank
Bangladesh	0	0	7
Bhutan	0.22016	22.016	6
India	0.38767	38.767	3
Maldives	1	100	1
Nepal	0.23071	23.071	5
Pakistan	0.39692	39.692	2
Sri Lanka	0.33913	33.913	4

Note: IEI=Index of energy intensity (kg of oil equivalent per capita).

Thus higher is the energy intensity the lower is the CO_2 emissions. In this study, energy intensity is measured by kg of oil equivalent per capita (constant 2005 US$). From table 5, it is found that Maldives takes the top ranking position and Pakistan, India, Sri Lanka and Bangladesh take second, third, fourth and seventh position respectively.

Index of Urbanization

The effect of urbanization on lowering environmental quality is similar to that of population, which is to say greatest at the upper-middle income level followed by the low income level, and is least in the lower middle income levels. This shows that higher urbanization further increases energy consumption per capita and increases CO_2 emissions because energy efficiency, energy saving technology and environmental protection are still low. The analysis presents that low middle and low income levels for the countries, urbanization should implement energy-using fashions and advocate energy-saving by the population. Living in urban areas during the process of urbanization. If it is considered the ranking position among SAARC countries, it has been seen that Maldives comes to the top of IU ranking. After that second to seventh position holds.

Table 6: Construction of urbanization index among SAARC countries

SAARC Countries	IU	IU %	Rank
Bangladesh	0.34250	34.250	2
Bhutan	0	0	7
India	0.05475	5.475	6
Maldives	1	100	1
Nepal	0.20511	20.511	5
Pakistan	0.21150	21.150	4
Sri Lanka	0.22007	22.077	3

Note: IUP=Index of Urbanization

Bangladesh, Sri Lanka, Pakistan, Nepal, India and Bhutan respectively. Since SAARC countries are low income levels category, so top ranking countries Green House Gas emissions tendency specially CO_2 emissions tendency much greater than other SAARC included countries.

Index of Technology

Technology is measured by energy intensity that is energy use (kg of oil equivalent per capita) and energy use (kg of oil equivalent) per $1,000 GDP (constant 2005 PPP). The higher is the energy intensity the lower is the efficiency of the economy and therefore higher CO_2 emissions. Another potential proxy for technology is carbon intensity. The technology term actually incorporates not only technology as it is usually conceived but also social organization, institutions, culture, and all other factors affecting human impact on the environment other than population and affluence. There are two ways in which technological change can lower environmental impact: (i) it can reduce the materials and energy used per unit of output, which is termed as energy intensity, and, (ii) it can substitute less harmful technology, which is termed as energy (fuel) switch. In the latter case, the fuel switch can take place either from high polluting fossil fuel (example; Coal) to less polluting fossil fuel (example; Natural gas) or from fossil fuel to non-fossil fuel. All three of the factors influencing

environmental impact and change are interrelated and future emissions will depend on the complex interactions among population growth, economic growth, and technological innovation.

Table 7: Construction of Technology index among SAARC countries

SAARC Countries	IT	Rank
Bangladesh	36.518	3
Bhutan	0	7
India	100	1
Maldives	0.462	6
Nepal	15.541	5
Pakistan	25.664	4
Sri Lanka	55.089	2

Note: IT= Index of technology

From ranking of IT, it is observed that India is the top position than Sri Lanka, Bangladesh, Pakistan, Nepal, Maldives and Bhutan. Because of top ranking position energy consumption intensity of India, Pakistan, and Bangladesh are greater than SAARC countries. So they are much liable for lowering environmental quality than others.

Conclusion

In this study, the environmental impact has been observed among different SAARC countries. For this purpose, different SAARC countries are arranged according to ranking by using an environmental index. The index value and ranking position leads to a conclusion that anthropogenic carbon dioxide emissions in SAARC countries are increasing and has more than double from its normal level and it is continuing to increase until the present. This increasing level is highly affected by (i) population, (ii) income level, but with poor demand for environmental quality, and (iii) technology use in producing goods and (iv) the sources of energy used by countries. It is observed that the low income countries among SAARC region are in a state that needs for technological assistance. Technological improvement of the country can decrease emissions in significant amount. Shifting to less energy intensive technologies should be needed to change the current trend of emissions. Investing in less energy intensive technology can change the current direction of CO_2 emissions. In this way, each country in SAARC region needs cooperation and commitment to improve the environmental condition.

References

Apergis, N., & Tang, C. F. (2013). Is the energy-led growth hypothesis valid? New evidence from a sample of 85 countries. *Energy economics*, *38*, 24-31.

Asafu-Adjaye, J. (2000). The relationship between energy consumption, energy prices and economic growth: time series evidence from Asian developing countries. *Energy economics*, *22*(6), 615-625.

Barlow, R. (1994). Population growth and economic growth: Some more correlations. *Population and Development Review*, 153-165.

Birdsall, Nancy, (1992): "Another Look at Population and Global Warming." Policy Research Working Papers. No.1020. The World Bank.

Book, I. (2011). Health Sector.

Bose, B. K. (2010). Global warming: Energy, environmental pollution, and the impact of power electronics. *Industrial Electronics Magazine, IEEE*, *4*(1), 6-17.

Ehrlich, P. R., & Holdren, J. P. (1971). Impact of population growth.

Goldstone, J. A. (2010). The new population bomb. *foreign affairs*, *89*(1), 31-43.

IPCC, Intergovernmental Panel on Climate Change (2007): "Climate Change (2007): Synthesis Report." IPCC, Cambridge.

Kohler, H.-P. (2012). Copenhagen Consensus 2012: Challenge Paper on" Population Growth".

Lutz, W., & Samir, K. (2010). Dimensions of global population projections: what do we know about future population trends and structures? *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*(1554), 2779-2791.

Meinshausen, M., Meinshausen, N., Hare, W., Raper, S. C., Frieler, K., Knutti, R., . . . Allen, M. R. (2009). Greenhouse-gas emission targets for limiting global warming to 2 C. *Nature, 458*(7242), 1158-1162.

Moss, R. H., Edmonds, J. A., Hibbard, K. A., Manning, M. R., Rose, S. K., Van Vuuren, D. P., . . . Kram, T. (2010). The next generation of scenarios for climate change research and assessment. *Nature, 463*(7282), 747-756.

Mudakkar, S. R., Zaman, K., Shakir, H., Arif, M., Naseem, I., & Naz, L. (2013). Determinants of energy consumption function in SAARC countries: Balancing the odds. *Renewable and Sustainable Energy Reviews, 28*, 566-574.

Samimi, A., & Zarinabadi, S. (2012). Reduction of greenhouse gases emission and effect on environment. *Journal of American Science, 8*(8), 1011-1015.

Satterthwaite, D. (2009). The implications of population growth and urbanization for climate change. *Environment and Urbanization, 21*(2), 545-567.

Shi, A. (2003). The impact of population pressure on global carbon dioxide emissions, 1975–1996: evidence from pooled cross-country data. *Ecological Economics, 44*(1), 29-42.

Stern, D. I., Common, M. S., & Barbier, E. B. (1996). Economic growth and environmental degradation: the environmental Kuznets curve and sustainable development. *World development, 24*(7), 1151-1160.

Titus, J. G., Park, R. A., Leatherman, S. P., Weggel, J. R., Greene, M. S., Mausel, P. W., . . . Yohe, G. (1991). Greenhouse effect and sea level rise: the cost of holding back the sea. *Coastal Management, 19*(2), 171-204.

Vitousek, PM, HA Mooney, J Lubchenco, and JM Melillo. (1997): "Human Domination of Earth's Ecosystems." Science 277:494.

York, R., Rosa, E. A., & Dietz, T. (2003). Footprints on the earth: The environmental consequences of modernity. *American Sociological Review*, 279-300.

Dr. Tapan K. Roy
Department of Population Science
and Human Resource Development
Rajshahi University, Rajshahi, Bangladesh

Md. Aminur Rahman
Department of Population Science
and Human Resource Development
Rajshahi University, Rajshahi, Bangladesh

Md. Abdul Kaium
Department of Population Science
and Human Resource Development
Rajshahi University, Rajshahi, Bangladesh

Dr. Brijesh P. Singh
Department of Statistics, Instt. of Science
Banaras Hindu University, Varanasi, India

Corresponding author: Dr. Tapan K. Roy
Email: roy.tapan@gmail.com