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Towards a Steady State Economy in Sri Lanka

A. T. Wijeratne[1], P. Dias[2] , N. Adhikari[3]

1. *Department of Physics, Faculty of Applied Sciences, University of Sri Jayewardenepura, Sri Lanka. Email : agraw@sjp.ac.lk*

2. *Department of Statistics, Faculty of Applied Sciences, University of Sri Jayewardenepura, Sri Lanka. Email : dias@sjp.ac.lk*

3. *E mail: nipuni.adhikari@yahoo.com*

Abstract

In general, it is desired that Sri Lankan economy shows growth. A growing economy brings waste production which leads environmental pollutions such as air pollution water pollution etc. At present, increasing population in Sri Lanka requires more natural resources to meet the market demand. The ultimate result is an imbalance in the biological cycles, and an irreversible change in both economic process and environment.

An irreversible economic process increases entropy. Ultimately, the entropy will reach its maximum value. Then everything will become standstill since there would not exist more energy to continue the economic process. As a solution, the concept of a steady state economy is structured.Sri Lankan economy was assessed within steady state economics to evaluate the present economic situation of Sri Lanka. A statistical analysis was carried out on Gross Domestic Product (GDP), population, energy use, CO2 emission through time series analysis and regression analysis,to identify the extent to which Sri Lankan economy has deviated from a steady state economy. Regression analysis indicates a strong relationship between GDP and CO2 emission. Total population size in Sri Lanka is increased from 9.9 million in 1960 to 20.48 million in 2013. CO_2 emission per capita is increased from 0.25 metric tons in 1960 to 0.65 metric tons in 2010. CO_2 emission is increased from 2259 kiloton in 1960 to 12831 kiloton in 2010.

Rapid growth rates, CO_2 emissions, population growth rates reveal that Sri Lankan economy is far apart from the concept of steady state.Transition to a steady state economy would require the implementation of new policies to restrict the utilization of nonrenewable resources. On the other hand it is mandatory to have legal regulations encouraging renewable resource use, energy efficiency, and reuse and recycling.

Key Words: Steady State Economy, Irreversibility, Entropy,GDP,CO_2 emission

Introduction

Centre for the Advancement of the Steady State Economy, defines a steady state economy as an economy with stable or mildly fluctuating size. (Czech, *et al.*, 2004). A steady state economy emphasizes on utilizing energy and resources within ecological limits while maintaining a stable level of resource consumption and population. The increase in the amount of goods and services produced per head of the population over a period of time, cause to increase the economic activity.

Transition to a steady state economy would require a significant change in attitudes of Sri Lankans. However, this cannot be achieved without a detailed explanation on the current economic situation of Sri Lanka. In this paper, it is attempted to identify some of major obstacles encountered in transition to a steady state economy.

In typical economic models the economic process is pictured as cyclic. The entropy change of a reversible cyclic process is zero. However, the entropy of an isolated system increases and that increase is irreversible. Therefore, in the universe which is isolated, the entropy is expected to increase continuously making no any processes reversible or cyclic. It can be said that the economic process accelerates the increase in entropy by transforming available energy and natural material to unavailable energy via work done. This unavailable energy is called the entropy and is described by second law of Thermodynamics.

A thermodynamic system achieves a steady state when the properties of the system are independent of time. If there is no flow of heat or particles, the system is said to be in equilibrium. For an open system which is in a thermodynamic equilibrium,

$$\frac{dS}{dt} = \pi - \varphi \qquad \text{-----------------} \ (1)$$

(Tome and Oliveira, 2012)

Where,

S-entropy of the system

π-rate of entropy production

φ-flow of entropy per unit time from the system to the outside.

t -time

Above equation states that the variation of entropy per unit time is not only due to the exchange of entropy with the environment but also due to the internal entropy production. If the system is in a non-equilibrium steady state, that is irreversible, then

$$\pi - \varphi > 0$$

In the equilibrium steady state, entropy is a constant. Therefore, all entropy generated within the system is continuously been given away to the environment.

That is

$$\pi = \varphi$$

John Stuart Mill, established the idea of the steady state economy, characterized by constant population and stocks of capital, in the middle of the 19th century. The increase of wealth is not boundless. The end of growth leads to a stationary state. The stationary state of capital and wealth would be a very considerable improvement on our present condition. A stationary condition of capital and population implies no stationary state of human improvement. There would be as much scope as ever for all kinds of mental culture, and moral and social progress; as much room for improving the art of living, and much more likelihood of it being improved, when minds ceased to be engrossed by the art of getting on. (Mill, 1909)

American Ecological Economist, Herman E.Daly stated that a steady state economy is an economy with constant stocks of people and artifacts, maintained at some desired level, sufficient levels by low rates of maintenance "throughput" that is, by the lowest feasible flows of matter and energy from the first stage of production to the last stage of consumption(Daly, 1991).

Daly (1991), introduced a ten point policy plan that will lead to a steady state economy.

1. Cap-auction-trade systems for basic resources. Cap limits biophysical scale. Auction captures scarcity rents for equitable redistribution. Trade allows efficient allocation to highest uses.

2. Ecological tax reform—shift tax base from value added (labor and capital) and on to entropic throughput of resources extracted from nature (depletion), through the economy, and back to nature (pollution).

3. Limit the range of inequality in income distribution—a minimum income and a maximum income.

4. Free up the length of the working day, week, and year—allow greater option for leisure or personal work.

5. Re-regulate international commerce—move away from free trade, free capital mobility and globalization.

6. Charging penalty rates on surplus as well as deficit balances—seek balance on current account; avoid large capital transfers and foreign debts.

7. Move to 100% reserve requirements instead of fractional reserve banking.

8. Stop treating the scarce as if it were non-scarce and the non-scarce as if it were scarce.

9. Stabilize population. Work toward a balance in which births plus immigrants, equals deaths plus out-migrants.

10. Reform national accounts-separate GDP into a cost account and a benefits account. Compare them at the margin, stop growing when marginal costs equal marginal benefits. (Daly, 2008)

Although this is a broad policy including banking and national accounts, mainly we are focusing on population, energy and pollutions. While Daly was instrumental in introducing the concept of Steady State Economy, which is essentially based on thermo dynamical considerations, Victor has applied the concepts of Steady State on more constrained basis to Canadian Economy, which has mainly focused on different scenarios including first low growth then no growth condition (Scenario No: 05, page 182) with a carbon tax and redistribution of income which tend to reduce greenhouse gas emission, unemployment, poverty and debt to GDP ratio as opposed to business as usual scenario.(Victor, 2008)

Materials and Methods

Data on Economic, Energy and Environmental indicators of Sri Lanka, from 1960 to 2013 were downloaded from the Global Economy.com. These data were then analysed and models were developed through time series analysis and regression analysis using software package Minitab 14 and Mathematica 9.0 to predict the behaviour of these indicators in future. These models were closely analysed to identify the present nature of Sri Lankan economy with respect to a steady state economy. In this study, it is mainly concerned with the effects of population, GDP, CO_2emission and energy use.

Results and Discussion

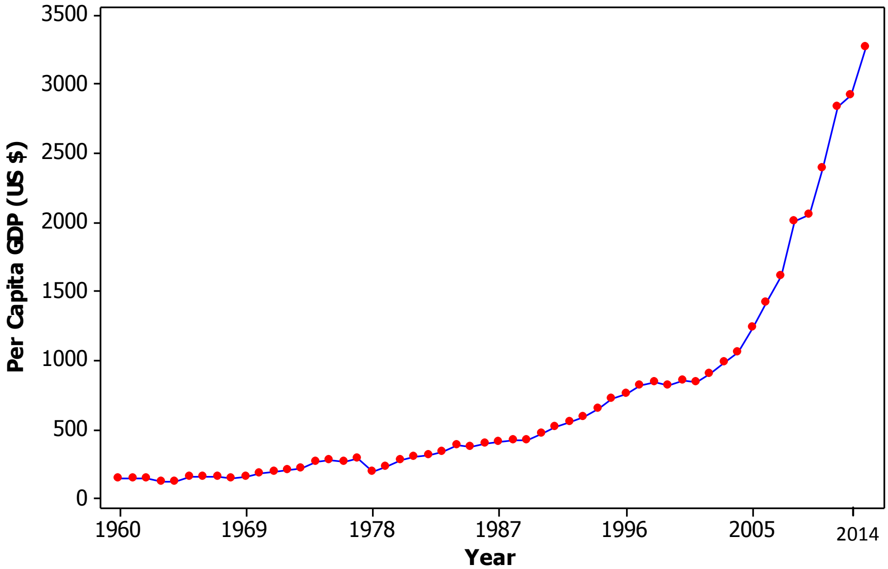

Figure 1: Per Capita GDP of Sri Lanka from 1960 to 2013

As shown in the above graph, in Figure 1.0, per capita GDP of Sri Lanka has increased from US $143.45 in 1960 to US $3279.89 in 2013.However, Per capita GDP has increased by 291.53% from year 2001 to 2013.Therefore, Per Capita GDP from year 2001 to 2013 was analyzed as follows:

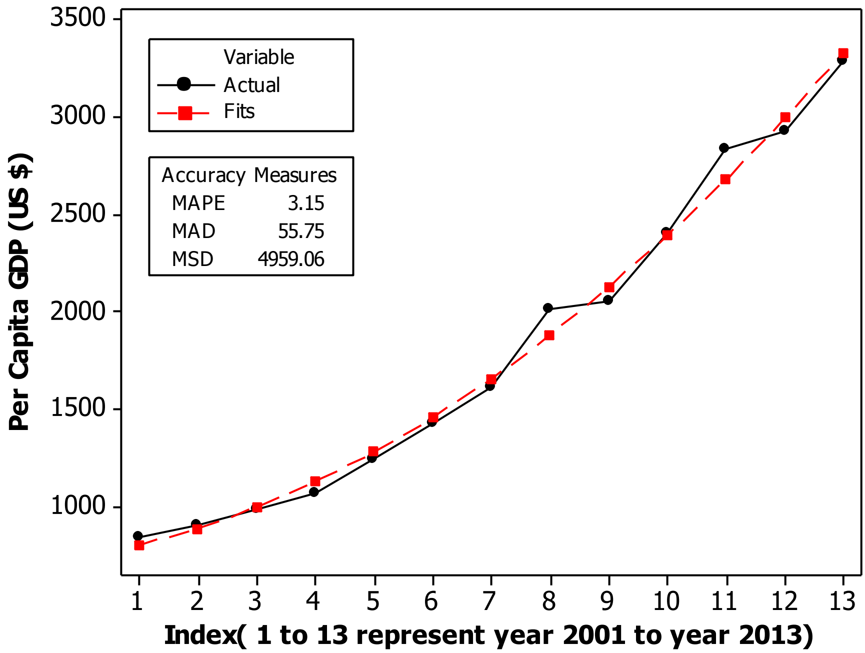

Figure2: Trend Analysis Plot for Per Capita GDP from year 2001 to 2013

In the six years, from 2007 to 2013, Sri Lanka's GDP has doubled. The economy of Sri Lanka, has been affected by natural disasters such as Indian Ocean earthquake in 2004, and 1983 to 2009 Civil war conflict. After the civil war, GDP per capita has increased by 59% from year 2009 to 2013.

As shown in Figure 2, MAPE (Mean Absolute Percentage Error) value of Quadratic Trend Model is comparatively low. Therefore, it can be selected as the best fit model to analyze the per capita GDP of Sri Lanka after year 2001.According to the Fitted Line Plot, relationship between Per capita GDP and time from year 2001 to 2013 can be expressed as follows:

$$y(capital) = 734.747 + 52.0391 \times t + 11.3443 \times t^2 \qquad \text{------------ (2)}$$

where, *y(capital)*=Per Capita GDP t=time

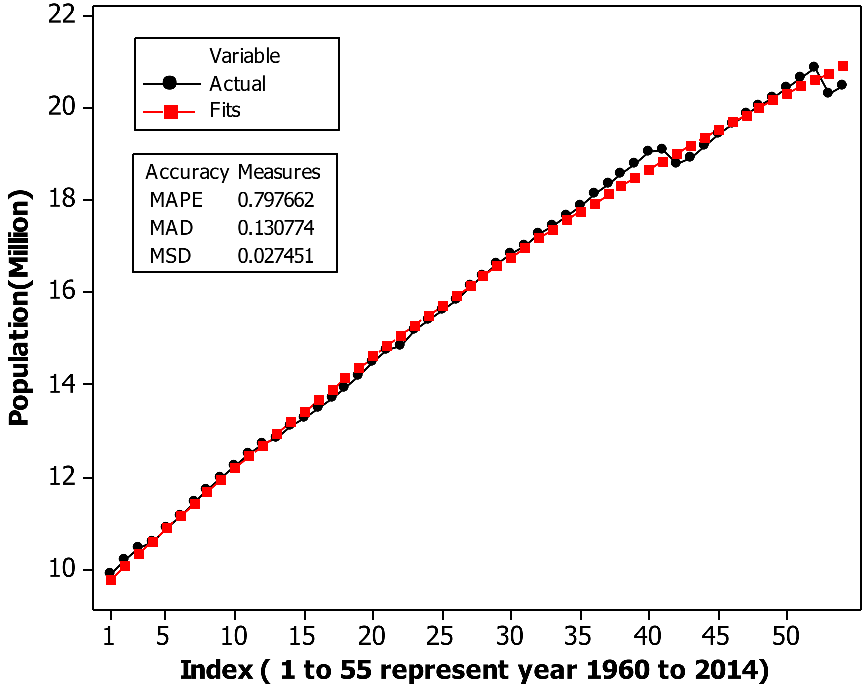

Figure 3: Trend Analysis Plot for Per Capita GDP from year 1960 to 2013

As shown in Figure 3, population of Sri Lanka has increased from 9.9millions in 1960 to 20.48millions in 2013. MAPE value of Quadratic Trend Model is comparatively low.Therefore, it can be selected as the best fit model to analyze the population of Sri Lanka.

According to the Fitted Line Plot, (Figure 3) relationship between population and time can be expressed as follows:

$$P = 9.49311 + 0.281405 \times t - 0.00129782 \times t^2 \quad \text{-------------- (3)}$$

P=Population t=time

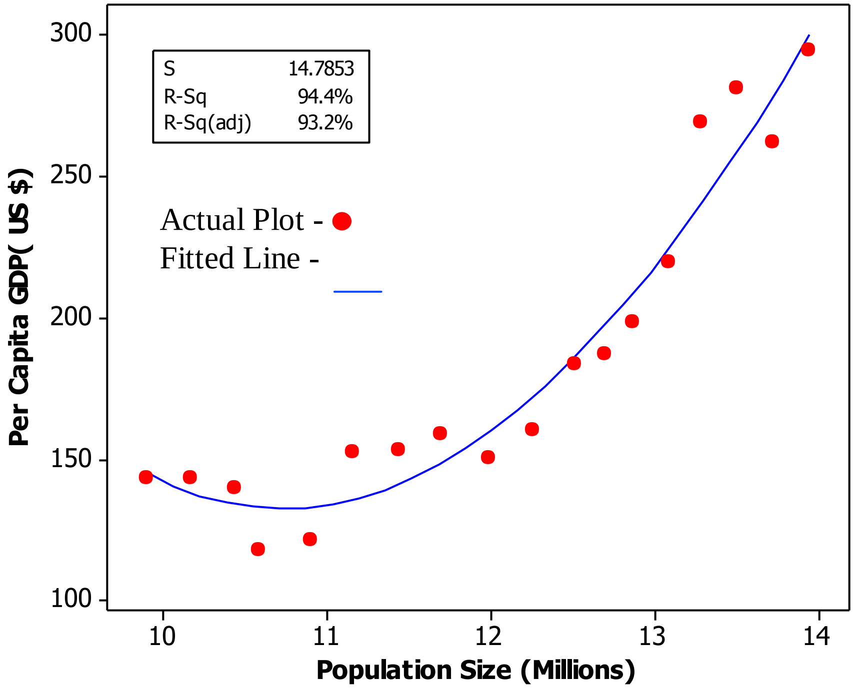

Figure 4: Per Capita GDP vs. Population of Sri Lanka (1960 to 1977)

According to the Fitted Line Plot,relationship between Per capita GDP and population from 1960 to 1977 can be expressed as follows:

$$Per\ Capita\ GDP = 2840 - 564P + 34.57P^2 - 0.516P^3 \qquad \text{----------- (4)}$$

where,*P* is Population and GDP is Gross Domestic Product

R-Sq value of 94.4% suggests a strong cubic relationship between per capita GDP and population from year 1960 to 1977.

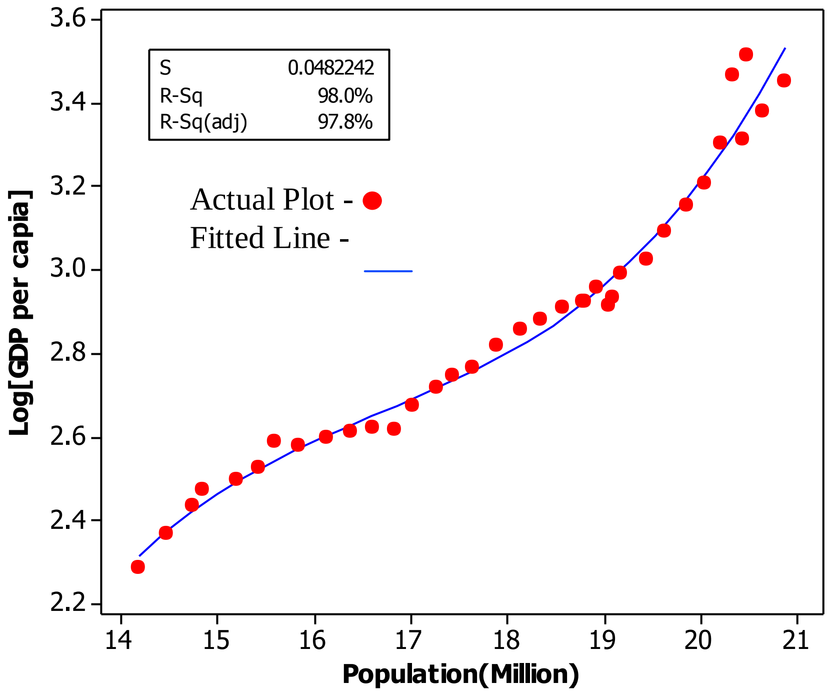

Figure 5: Per Capita GDP vs. Population of Sri Lanka (1978 to 2013)

According to the Fitted Line Plot,relationship between Logarithmic value of Per capita GDP and population from 1978 to 2013 can be expressed as follows:

$$\log_{10}[GDP\ Per\ Capita] = -28.58 + 5.421P - 0.3190\,P^2 + 0.006371\,P^3 \quad \text{-------- (5)}$$

R-Sq value is 98.0%.

where; *P* is Population

It is quite apparent that the cubic relationship yields a better fit with the given data set. Therefore, it is suggestive that GDP tends to increase with increasing population.

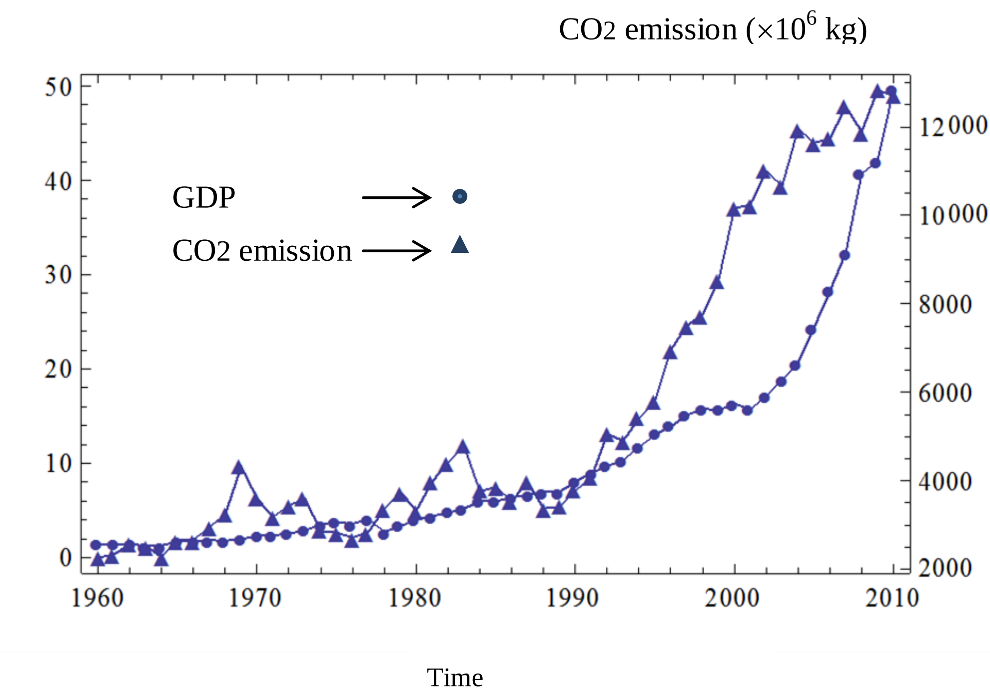

Figure 6: GDP and CO_2 emission in Sri Lanka from year 1960 to 2010

From 2002 to 2010, as GDP increase by 190%, overall CO2 emission has increased by 16%.

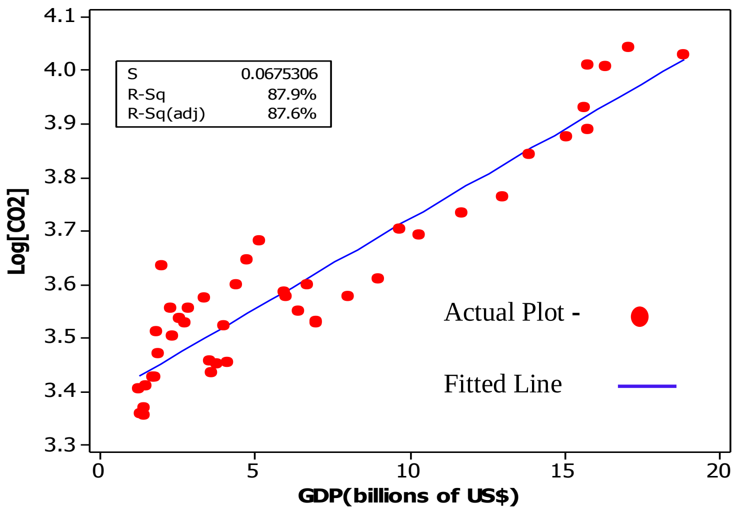

Figure 7: Logarithmic value of CO2 emission vs. Gross Domestic Product in Sri Lanka (1960-2003)

According to the fitted line plot, Logarithmic value of CO2emission and GDP of Sri lanka, from year 1960 to 2003 shows a linear relationship with a correlation of 0.937.

$$\log_{10} CO_2 = 3.386 + 0.03367\, GDP \qquad \text{------------- (6)}$$

R-Sq value indicates that 87.9% of an observed variation in the value of Log [CO2], is due to the model (or due to change in GDP) and only 12.1% is due error or some unexplained factor. Therefore, this data fits well to the linear model.

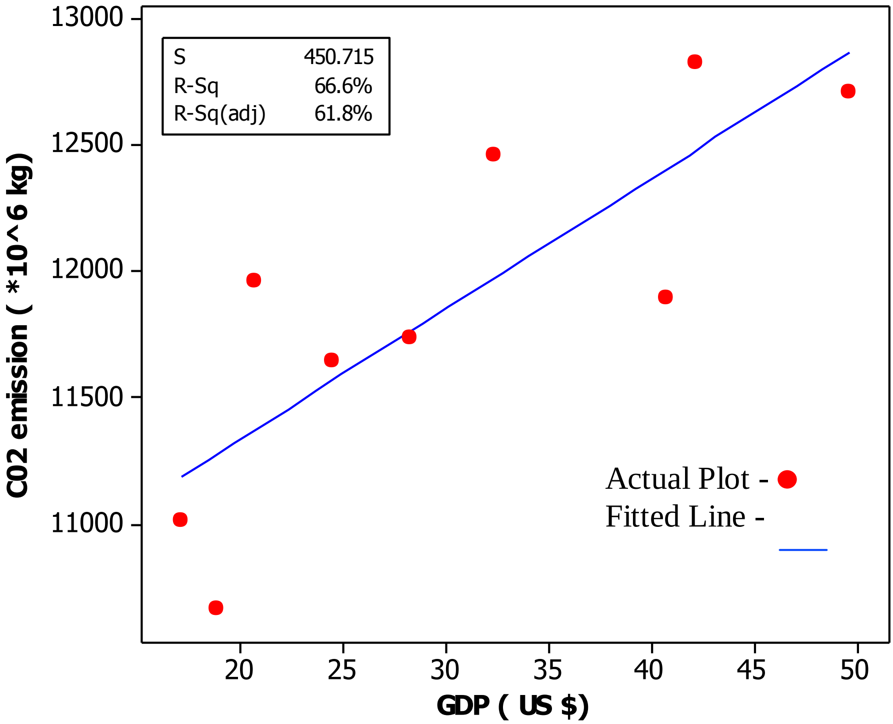

Figure 8: CO2 emission vs. Gross Domestic Product in Sri Lanka (2002-2010)

According to the fitted line plot, CO2 emission and GDP of Sri Lanka, from year 2002 to 2010 shows a linear relationship.

$$CO_2 = 10302 + 51.76\,GDP \quad \text{-----------} \; (7)$$

Thus, it can be concluded that CO2emission has increased dramatically due to proliferation of economic activity in Sri Lanka, causing changes in the atmosphere, which is inimical to the living beings.

It is important to mark that the economic growth is tightly bound to the utilization of energy and resources. Therefore, a growth in GDP would require a greater energy and this would in turn release waste to the environment.

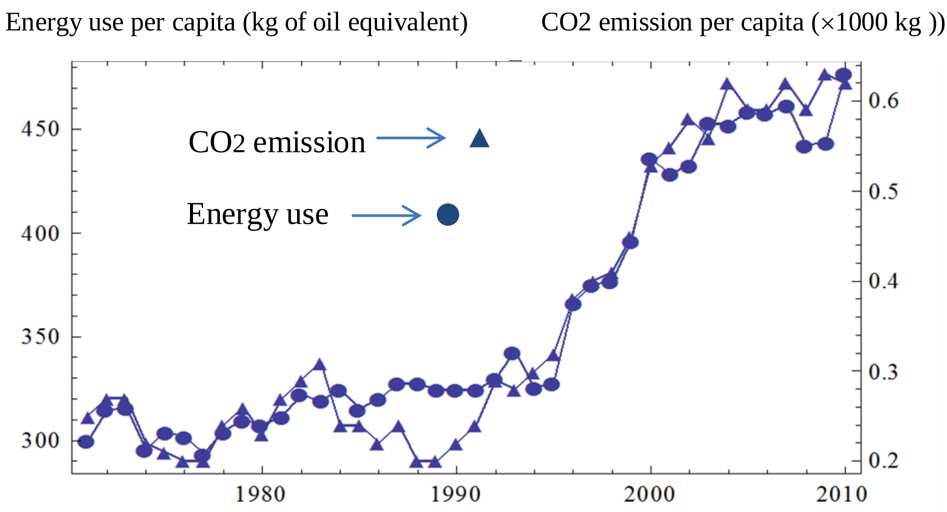

Figure 9: Energy use per capita and **CO_2**emission per capita in Sri Lanka from year 1971 to 2010[1]

Since a large part of energy demand in Sri Lanka has been metby fossil fuels, it is highly likely that an increase in population will strengthen the negative impact on the environment by increasing waste production and nonrenewable resource use. From 1971 to 2010,as energy use per capita increased by 59%,CO2 emission per capita has also grown by 148% (Figure 9).However it is important to note that, CO_2 is one of the major contributors of greenhouse effect, which leads to global warming and ultimately climate change.

This suggests that contemporary Sri Lankan economy diminishes the natural system on which it depends. This may give rise to a wide range of global environmental problems such as climate change, biodiversity loss, stratospheric ozone depletion, ocean acidification, chemical pollution etc.

[1] 1 kg of oil equivalent=11.63kWh. Kilogram(s) of oil equivalent (kgoe) is a normalized unit of energy conventionally, it is equivalent to the approximate amount of energy that can be extracted from one kilogram of crude oil.

It is true that the measurement complexities associated with a steady state economy restrict the determination of exact level of through put, waste production, renewable and nonrenewable resource consumption. However, GDP per capita of Sri Lanka has grown significantly since 2009, and this has been made realized by mainly using nonrenewable resources such as fossil fuels. As a consequence, CO_2 emission has increased dramatically in the last 4-6 years. At the same time population growth which is one of the main determinants of economic growth and waste production has been increased exponentially in the last 4 – 6 years.Therefore, it can be argued that the current state of the Sri Lankan economy is far apart a steady-state economy

Presently the Sri Lanka is consuming the accumulated natural capital at an alarming rate, creating disorder in the world. Increasing energy demand and the high dependency on fossil fuels seem to be the major obstacles which restrict the Sri Lankan economy to move towards a steady state.Therefore, economic rethinking is essential to improve human wellbeing while minimizing the consumption of material and energy of Sri Lankan economy.

Sri Lankan economy has failed to incorporate the importance of natural capital in the system of National Accounts. This has led to the degradation of environment and natural resources. As a solution sustainable development division of the Ministry of Mahaweli development and Environment has taken necessary steps to initiate a green accounting system in 2012.

As Sri Lanka is constantly exposed to solar energy, one of the most valuable natural resources in the world,it is time to invest in more solar power plants.At the same time responsible bodies should take necessary actions to enhance the contribution from wind energy source in generating electricity. Accordingly, Sri Lankan authorities should consider the feasibility of establishing policies related to population growth, efficient energy consumption, renewable resources, recycling and reuse in order to move towards a steady state.

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