

## **SOME ISSUES IN THE SUSTAINABLE DEVELOPMENT OF THE GLOBAL ENVIRONMENT**

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### **Summary**

Sustenance of life on the Earth is contingent on a dynamic equilibrium involving the ecosystem. Human activities across a spectrum of endeavors are seriously threatening the stability of life support systems on the Earth. An agenda for action by all nations is indispensable if an environmental crisis is not to be precipitated in the near future. In this context, the article explores a selection of 24 issues, and presents some solutions. The experiences of Singapore in addressing some of these issues are also discussed.

### **1. Introduction**

The Earth is basically a spaceship cruising through outer space at a speed of about 30 kilometers per second. In this cosmic odyssey, the inhabitants have to make do with whatever is available on board. A conductive atmosphere, an ocean teeming with marine life, and a terrestrial terrain with various resources as well as life forms constitute the ecosystem of the Earth.

By virtue of their ascendancy in the evolutionary pyramid, humans have become the self-anointed custodians of the globe. Human activities across a spectrum of endeavors are causing increasing damage to global life support systems. Because of the interconnectedness of the global ecosystem, such problems present ramifications which transcend regional or national boundaries. The actions of one nation or region affect the others as well.

Environmental problems come from a medley of issues—population explosion, resource depletion, deforestation, pollution, and so on. If these problems are not addressed in time, humankind is in danger of becoming an endangered species.

The purpose of this article is threefold:

1. To explore a selection of issues of relevance to the current environmental debate,
2. To share the experiences of Singapore, a developing nation, on some of the issues, and
3. To present some possible solutions.

It is meaningful to address the various issues systematically.

## **2. Issues in Sustainability**

### **2.1 Protection of the Atmosphere**

The Earth's atmosphere contains life-sustaining gases, the more important ones being oxygen for respiratory processes, carbon dioxide for photosynthesis, and ozone for filtering out the harmful ultraviolet radiation from the sun.

Human economic activities are spewing out gases that are not part of the atmospheric composition as well as increasing the levels of others. This has the effect of upsetting the balance of the ecosystem and producing ramifications of a serious nature.

Some statistics serve to exemplify the gravity of the situation:

- Combustion of fossil fuels as well as use of nitrogenous fertilizers is causing a threefold increase in the amount of nitrogen-based gases such as nitrogen oxides and ammonia released into the atmosphere. These nitrogen oxides react with rain water and fall back to the Earth as acid rain.
- Emission of sulfur compounds into the atmosphere by the burning of coal and oil as well as during petroleum refining is increasing by two times as much as the sulfur spewed by natural processes.
- Deforestation contributes 20% of the increase in carbon dioxide levels.
- Industrialized nations are producing more greenhouse gases than those in the developing world.
- Ozone concentration in the stratosphere is decreasing dramatically as a result of chlorofluorocarbons (CFCs) introduced into the atmosphere.

The Earth's atmosphere is the last vestige of commonality in a world divided by terrestrial boundaries. The atmosphere recognizes no national boundaries, and the environment-depreciating activities of one nation impact on all the others through a web of interactions. More than any other issue, the atmosphere presents a platform to work out a truly global solution to which all nations would be signatories and custodians. However, there is a long way to go before this can be a reality.

The actions of Singapore show that even a tiny nation can play a useful role in contributing towards reduction of air pollution. It has adopted a lot of measures in this regard. The Air Pollution Control Act was introduced to ensure that industries comply with rigorous protocols. They are required to install pollution control equipment as well as conduct regular source checks on their emissions. Because of worldwide concerns

about the effects of particulate lead on human health, unleaded petrol (gasoline) was introduced in 1991 and priced lower than leaded petrol. The use of leaded petrol was phased out completely in 1998. All vehicles are required to undergo mandatory vehicle inspection annually and are tested for, among others, emission. Because the high sulfur content in diesel leads to increased emission of sulfur dioxide by vehicles, the level of sulfur in diesel was further reduced in 1999 from 0.3% to 0.05% by weight. All vehicles imported from 1991 have been required to be fitted with catalytic converters so that emission is reduced to only carbon dioxide and water vapor. Modern incineration plants are in operation in Singapore; such plants do not introduce dioxin into the atmosphere. (Excessive dioxin emission results from incomplete combustion of wastes in old incinerators, where the temperature used is lower.) The high temperature incinerators used in Singapore utilize modern combustion technology to ensure optimal retention times of wastes in the furnaces, and are also equipped with flue gas retention systems. The use of CFCs was phased out in 1998, two years ahead of schedule, as required by the Montreal Protocol.

Much could be done to alleviate the severity of atmospheric contamination:

- Make it mandatory for industries that produce exhaust gases to install pollution control equipment. (The use of tall smoke stacks to spew out pollutants above the inversion layer is not a good example of pollution control for, whilst it decreases local pollution, winds export it to other countries.)
- Nations should monitor ambient air quality standards for the major pollutants and particulate matter and initiate remedial measures where necessary.
- Phase out fossil fuels, and replace them with renewable sources such as solar, wind, hydroelectric, and others.
- Tax industries that emit pollution.
- Phase out conventional automobiles for less polluting versions. For example, it has been established that engines running on natural gas or hydrogen produce far less pollution than those running on petrol or diesel.
- The industrialized world should assist the developing world in phasing out CFCs and halons for environment-friendly substitutes.
- Intensify research on the use of clean coal technology, as coal releases 60% more carbon dioxide into the atmosphere than other forms of fossil fuel.
- Institute mechanisms to trap methane gas emitted by landfills, and use it as a fuel. (Methane is 25 times more effective in causing global warming than carbon dioxide.)
- Switch to sustainable modes of agriculture, as current agricultural practice contributes 14% towards the emission of greenhouse gases.
- Technology transfers to the developing world involving energy-efficient equipment, waste-reducing technologies, and pollution prevention equipment should be accelerated.
- Decrease beef production so that fossil fuel use in agriculture is decreased.

## **2.2 Demographic Dynamics and Sustainability**

The population of the world has more than tripled in the last century—from 1.6 billion in 1900 to 6.0 billion in 2000. Demographers have calculated that in the recent past, the population has been doubling every 40 years. If this trend continues, there will be 170 quadrillion people on the planet by the year 2600. The Earth's ecosystem would not be able to support such vast numbers of people.

The current annual rate of increase in population is about 3%. Most of the increase is occurring in developing countries—a factor that is also exacerbating their political, economic, and environmental woes. In contrast, nations in the industrialized world are facing a situation whereby birth rates are not sufficient for replacement.

An enlightened approach towards population control is necessary. Birth rates in a nation must be indexed to economic growth and capped at a sustainable level. Developing nations have to realize that economic development as well as respectable standards of living for their people are not compatible with unfettered increases in population. The scenario is compounded by some religious groups which view population control as an affront to their beliefs, and by minorities who view it as a subtle form of ethnic cleansing.

The experience of Western nations has shown that economic development and better education for women are two factors that have the potential to arrest growth rates in population. China's one child policy, which has been instrumental in drastically reducing population increases, may not be the ideal model for developing nations but it has the proven advantage of being available as a policy instrument to ensure that individual interests are subservient to long-term national interests.

One factor commonly overlooked in the population equation is that declining birth rates are not the sole answer to the population problem. This is because global life expectancy is also increasing—it has doubled in the twentieth century from 30 to 64 years. In the long run, this would lead to increases in the overall size of the population. This is not without its attendant problems as older people consume a disproportionate share of medical, social, and public services.

Singapore has been remarkably successful in its birth control policies. The annual rate of increase in births is about 2%, though the rate of population increase is slightly greater than this due, in part, to a liberal immigration policy. Couples generally do not have more than two children because of various disincentives—no paid maternity leave for the third and subsequent child, no subsidy in delivery charges for these children, and least priority for these children to be admitted to a school near the family residence. Also, the high cost of living is a factor—the practice is for both parents to work. To help arrest the declining birth rate, with effect from 1 April 2001, there will be paid maternity leave and other benefits in respect of the third child.

## **2.3 Sustainable Use of Energy Resources**

The fossil fuel resources of the earth represent a nonrenewable commodity because the

timescale required for their formation is measured using geological standards. They include coal, oil, and natural gas, three of the fuels commonly used to generate electricity. In fact, 95% of all the energy used for commercial operations in the world is provided by these fossil fuels.

The rate at which fossil fuel resources are being depleted would be precipitating an energy crisis in the not too distant future. Some statistics are presented below:

- Of the 600 billion tons of oil endowed on the Earth, 50% are not economically recoverable, based on current market prices. As of 1990, the proven reserves were about 1 trillion barrels, enough to last till 2040, assuming a consumption rate of 20 billion barrels per year.
- Of the 285 trillion cubic meters of natural gas endowed on the Earth, the proven reserves are about 912 trillion cubic meters; based on present consumption rates, this would last until about 2050.
- Of the 10 trillion tons of coal endowed on the Earth, the proven reserves will last till 2200.

The 20 richest nations in the world together account for 80% of the annual consumption of natural gas, 65% of the oil, and 50% of the coal—the resources that contribute immensely to global warming.

Clearly, such rates of consumption are not sustainable. The high rates of consumption are also aggravated by industrial processes and equipment which guzzle energy unnecessarily because of inefficient design as well as wasteful practices. For example, the building sector can cut energy consumption by more than 75% by incorporating a range of measures—improved lamps, advanced building materials which drastically reduce loss of heat in cold countries, and simple common sense measures by the individual. Many lighting innovations such as compact fluorescent lamps are now available. If a 75 W incandescent lamp is replaced by an 18 W compact fluorescent lamp that lasts 10 000 hours, 730 kg of carbon dioxide and 8 kg of sulfur dioxide would not be released into the atmosphere. Superwindows, which reduce heat losses by 20–50%, as well as wavelength selective glasses, which cut 90% of the heat while maintaining transmission of visible light, are all available but used only sparsely. They are expensive, but when costs are amortized over a longer time frame, they are not only cheaper but are more environment-friendly.

Industrial processes rarely operate in the energy range predicted by the first and second laws of thermodynamics. Obsolete equipment and those that are energy guzzlers are still rampant. For example, China and India use four times more energy than Japan to make a ton of steel. Conventional electric motors consume 70% of the energy used in industries in developing countries. Improved versions which consume much less energy are available in the West and in Japan but not in developing nations.

Savings can be generated in the automobile sector as well. About half the world's oil is used by automobiles. Besides causing global warming through exhaust gas emissions, they also use energy very inefficiently. The technology is available to triple the mileage

per liter but is not popularized commercially. Energy-efficient vehicles need to be introduced on the roads rapidly—hybrid vehicles, powered by petrol and electricity, are now available, and tax incentives can be given to promote their use.

The foregoing scenario suggests that by reengineering industrial processes, building operations, and automobile dynamics, tremendous amounts of energy can be saved. The payback in terms of drastic reductions in global warming, waste generation, and resource depletion can be achieved without compromising economic growth.

Developing countries such as Malawi and Haiti that are reliant on biomass for 90% of the energy needed for heating and cooking are also causing global warming and deforestation through their energy practices. The situation is brighter in nations such as Norway, which produces 90% of its energy by hydroelectricity, as well as in New Zealand, Switzerland, and Brazil, where the figure is 75%. Such practices come within the framework of sustainable development as they are reliant on renewable sources of energy. But whereas hydroelectric power accounted for 40% of the world's electricity generation in 1930, it is now accounts for only about 25%.

Reducing subsidies for fuel costs can make a tremendous difference. For example, in Singapore, high surcharges are imposed on the prices of petrol and diesel. This attempt at pricing a nonrenewable commodity has played a useful role in controlling wasteful and unnecessary use of vehicles. Also, there is official encouragement to use public transport. In this context, Singapore has introduced some radical measures to reduce fuel usage: 100% tax on cars, certificates of entitlement for purchase of cars, a comprehensive underground mass rapid transit system to promote the use of public transport, electronic road pricing strategies to control usage of vehicles, real-time traffic alert systems to warn vehicle users to avoid congestion hot spots, and compulsory deregistration of vehicles after 10 years of use. An island-wide highway network plus well-surfaced roads contribute to better road geometrics besides minimizing fuel wastage by vehicles. All these have helped to reduce fuel use.

There is an urgent need to explore alternative forms of energy in order to reduce resource depletion and environmental degradation. A proactive approach in fostering the use of alternative technologies in energy operations must be adopted:

1. Research and development (R&D) on the use of photovoltaic cells to generate electricity at competitive costs needs to be accelerated. With appropriate devices to efficiently store the electricity produced, the cells can be popularized for small-scale adoption. The cumulative savings attained will be substantial, especially in tropical countries.
2. Use of fuel cells to produce electricity needs to be promoted intensively, especially the use of liquid hydrogen fuel, which can be obtained by the electrolytic decomposition of water.
3. Technologies to harness wind power need to be made available to the developing world, where geographical conditions permit their use.
4. Government action needs to be urgently initiated to fuel the market penetration of new technologies which contribute to energy savings. The Public Utilities Board in

all nations can spearhead this initiative—for example, they can make available efficient lighting systems, indeed mandate the use of such systems. Such initiatives may seem unpalatable in the short term but are environmentally desirable in the long run. There are also additional cost savings in that building of new power plants for generating additional capacity can be delayed further.

5. Deregulation of the energy market can be considered, with the intention of offering energy at prices that factor in the environmental cost. This can lead to new players entering the market with their product innovations and alternative technologies.
6. Compulsory energy audits must be promoted for households and industries that are energy guzzlers.
7. Pricing strategies should be introduced to discourage heavy users.
8. Developing nations need to emulate the measures popularized in the US and in Japan, where minimum efficiency standards from an energy standpoint are imposed on electrical appliances.

Energy is the locomotive that powers the global economy. The sustainable use of energy resources dictates that a review of contemporary practice be done in all sectors of the economy and that proactive action be initiated to avert wastage of natural resources.

## 2.4 Deforestation

The Earth's forests play a crucial role in maintaining ecological equilibrium:

- Through the process of photosynthesis, they remove carbon dioxide from the atmosphere and give out oxygen.
- They provide habitats for more species than any other land system.
- They help control soil erosion.
- They diminish the severity of flooding.
- They are giant water sponges which regulate the flow of water for recharging aquifers, springs, and streams.

In the past 30 years, more than half of the world's forests have been destroyed for generating cropland, rangeland, fuelwood, dams, reservoirs, and residential land. In fact, every second, an area the size of two soccer fields is being destroyed by humans. While in 1950, 30% of the Earth was covered with tropical forests, the figure dropped to 12% in 1975 and 6% in 1990. During the past 30 years, Central America has lost over 70% of its forest cover. In India, over half of the land was forested in 1900, while in 1990 the figure was 14%; it is even lower now.

Whilst there is justification for clearing forests to meet basic needs of nations, it has to be managed judiciously so that sustainability is not compromised. Provision of cropland is justified in the beginning—higher yields later must come more from use of high-yielding hybrids and innovative farm practices such as selective use of pesticides and organic farming than from clearing forests for increasing the absolute yield.

It is a matter of concern that many of the forests are being cleared to support colossal

projects of multinational corporations. For example, building cattle ranches to produce raw and canned beef is a wasteful exercise—each 60 g of hamburger made from beef imported from Central America means the loss of an area of tropical rain forest the size of a small kitchen. After being in use for 5–10 years, the land can no longer be used for grazing, and more forests will have to be cleared. Indeed, it has been shown that 70% of the tropical forests in Central America have been lost in the last 25 years and converted into rangeland to produce beef for export for use in hamburgers, hot dogs, luncheon meats, and pet food. Commercial logging for paper mill operations is also wasteful. Conservationists reckon that 50% of waste paper can be recycled. Higher per capita paper consumption in the developed world for a myriad of uses is also fueling the depletion of forest cover. Indeed, a World Bank report in 1990 predicted that of the 33 nations that were net exporters of tropical timber in 1990, only 10 would have any timber left for export in 2000.

Even though Singapore is a very small nation, it still has significant forest cover. This has been achieved by innovative land use which does not necessitate the clearing of too much forest for housing and factories. The emphasis is more on vertical living and flatted factories (these are factories sited in special high-rise buildings). Also, there is a very comprehensive program to promote the greening of Singapore by the planting of trees and shrubs. The program was started in the 1960s. Planting of trees peaked in 1976—150 000 were planted. The pace decreased later, not because of slackening of drive but because almost every inch of urban space and roadside is now covered by greenery. Singapore is frequently referred to as the green city. The one million trees and seven million shrubs planted all over Singapore together occupy a substantial area—the net effect of deforestation is thus much less.

The tropical forests are the heritage of humankind and are needed for sustainable development. To arrest deforestation, the following measures need to be implemented:

- Stop government subsidies for building rangeland in forests.
- Ban beef production on cleared forest land.
- Encourage banks to conduct an environmental audit so that money is not lent for use in projects that deplete forest cover.
- Provide fiscal incentives for villagers to raise tree farms or fuelwood trees in areas abandoned in the forest.
- Plant rapidly growing varieties such as leucaenas, which also serve as fuel.
- Require all nations to set up paper-recycling equipment. (About 45% less energy is required to produce the same mass of paper from recycled newsprint as from trees.)
- Remove tax subsidies and fiscal incentives which make production of paper from trees cost effective.
- Launch a massive internationally funded program to increase the world's forest cover. For example, Japan has been able to increase its forest cover to about 70% of its land area while China's ambitious reforestation program at the rate of 4.5 million hectares a year over the last few decades has significantly compensated for the logging of most of its forests about a thousand years ago.
- Industrialized nations write off the debts of impoverished nations in return for



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### **Bibliography**

Bailey R., ed. (1995). *The True State of the Planet*, 472 pp. New York: Free Press. [This presents alternative insights about environmental problem from various authorities.]

Castillon D. A. (1995). *Conservation of Natural Resources*, 470 pp. Madison: Brown and Benchmark.