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Review

Integration of social, ecological, political and technological issues into economic development programs: Key to sustainable development of human society

Rajiv K. Sinha[1]*, Brijalkumar Soni[1] and Binod Shankar[2]

[1]School of Engineering (Environment), Griffith University, Nathan Campus, Brisbane, QLD-4116, Australia.
[2]Department of Environment and Water Management, A.N. College, Patna, India.

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We need to plan for 'Development without Destruction' and manage our environment based on the ethical principle of social equality, economic prosperity with ecological security to achieve the goals of sustainable development. Environmental management and economic development programs should go hand in hand for achieving sustainability in global human society. Changes in the way we develop our economy, eat and drink, live and move, use and discard (as waste) the Earth's resources, enjoy our lifestyle are needed to be changed quickly to bring us back into balance with our life support systems on Earth. We have also to overcome the 'greed' of having more and be 'contented' after our 'needs' are fulfilled. Greed based society can never be sustainable. The key to growing sustainably is not to produce less but to produce differently, in a way which is environmentally friendly and compatible, that is, by embracing the philosophy of 'Cleaner Production'; not to consume less but to consume judiciously and efficiently within the regenerative capacity of the Earth ecosystems and with minimum waste generation.

Key words: Technological, social, economic, ecological and political considerations, good health, social equity, eradication of poverty.

INTRODUCTION

Major environmental issues affecting human future and sustainability on earth

Environmental problems of major concern are local, regional/national and global. The local concerns are air, water and noise pollution, declining groundwater table and increasing shortage of potable water, chemical spills and contaminated sites (land), acid sulfate soil, indoor air pollution and household hazardous wastes, urban sprawl and congestion, increasing health risks of urban residents, waste landfills and toxic emissions, solid waste (specially plastic waste) and sewage, green-land clearing and threatened species. The regional concerns are rural decline, declining rain and depleting natural water resources, increasing soil salinity, increasing natural and man-made disasters, disposal of chemical and radioactive wastes, ocean oil spills and marine pollution, degrading coastal ecosystems, acid rains etc. The global environmental concerns are threat of global warming and climate change, stratospheric ozone depletion, deforestation and biodiversity erosion, overpopulation and resource depletion especially in poor developing countries (Sinha, 2006).

Vanishing water resources on earth: Destroying the elixir of life

Out of the total water on earth, only 2.5% are freshwater, 97.5% are seawater and only less than 1% is useful for

*Corresponding author. E-mail: Rajiv.Sinha@griffith.edu.au.

human use and consumption which are also being destroyed by human wastes and chemicals. Underground water table is rapidly falling throughout the world. Within 25 years, half of the world's population could face hardship in finding enough freshwater for drinking, sanitation and food production. About 3 million litres of water is needed to produce 1 ha of corn; about 12 to 20 million litres to produce 1 ha of rice; about 250 L to produce 1 kg of wheat; about 25,000 L to produce 1 kg of meat; about 50 L to produce 1 L of whisky; about 250 L to produce 1 kg of steel and about 18,000 L to refine 1 ton of petroleum. About 45 industrial chemicals have been found in surface water. They are 'Endocrine Distruptors' in very low-parts-per billion. The cost of providing safe drinking water and sanitation to everyone in the world by 2025 will be US $ 180 billion per year.

Chemicals in the breathing air: Destroying the source of life on earth

Several millions tones of gases, carbon monoxide (about 106 million tonnes), carbon dioxide (4550 mt), sulfur dioxide (90 mt), oxides of nitrogen (60 mt), methane (84 mt), hydrocarbons (47 mt), CFC and halons (1 mt) and suspended particulate matter (30 mt) enter into our atmosphere every year from our industries and automobiles. Diesel vehicles emit over 100 micro-particles several of which are carcinogenic. Some 189 hazardous air pollutants (HAPs) have been identified in the atmosphere. UNEP estimates that over 3 million people in world die every year from air pollution related diseases and the non-cigarette smoker lung cancer rate due to outdoor air pollution in world today is estimated to about 2000 cases per year. According to WHO, coal power plants in the U.S. cuts short nearly 24,000 lives, including 2,800 from lung cancer and nearly 38,200 from heart attacks each year.

Degrading and eroding soil mantle: Destroying the food base on earth

Billions of tones of top soil (the fertile layer) are eroded away every year, being washed away into the sea or carried away with wind converting into wasteland. Every year, nearly 27 million hectares or say, 47 ha min^{-1}, of valuable fertile land are lost by desertification. Every minute a chunk of 'fertile agricultural land' of the size of tennis court is being converted into wasteland. Over the last two decades, the world has lost some 500 million metric tons of topsoil. Only the 'top thin layer' of the soil with humus is vital to grow food and is sustaining the entire civilization. Formation of just 1 cm of soil from parent rock take from 100 to 1,000 years and 2.5 cm of topsoil can take from 100 to 2,500 years. FAO has warned that the world's soil was degrading so fast that in little more than 30 years it might no longer be able to feed its growing population.

Depleting forest and biodiversity: Destroying the protector of life on Earth

Each year, around 17 to 18 million hectares of tropical forests rich in species diversity are cleared for timber, paper and fuel wood, and for fodder growing to export to meat producing industries in Europe and America. Every day a minimum of 3 (some put it 30) species of life is permanently disappearing from the face of Earth and at current rate of habitat destruction it can become 3 species every hour in coming years**.** Disappearance of 1 plant species may eventually lead to the extinction of up to 30 insect and animal species in the food chain as they depend upon plants for survival. Meat eating society is taking heavy toll on our biodiversity. The same amount of plant food that would feed 1.5 billion pure vegetarians would only feed 210 million meat eating people. Each time we take a medicine; there is one chance in two that our purchases owe its origin from wild species. A number of them are 'life-saving' medicine. Besides green plants are the main 'source of life sustaining oxygen in air' and 'sink of greenhouse gas CO_2' on earth.

Piling toxic chemicals on earth: The demons of development and inducer of deadly human diseases

Worldwide about 80 to 100,000 chemicals are in use every day in our industries and other developmental activities and some 1000 new chemicals are added each year. There are some 861 neuro-toxic chemicals in use in our cosmetics, perfumes and toiletries. The deadly chemicals DDT and PCBs have reached even up to the poles. A relationship between 'chemicals and cancer' is scientifically proved and women are more vulnerable. According to UNEP and WHO, some 25 million farmers and agricultural workers are poisoned by chemical pesticides every year and nearly 3 million people suffer from 'acute pesticide poisoning' and some 10 to 20 thousand people die every year from it in both the developed and the developing countries. Studies indicate that there is significant amount of 'residual pesticides' contaminating our food stuff long after they are taken away from farms for human consumption. Vegetable samples were contaminated 100% with HCH and 50% with DDT. US scientists predict that up to 20,000 Americans may die of cancer, each year, due to the low levels of 'residual pesticides' in the chemically grown food (UNEP Report, 1992). Exposures to chemical pesticides are linked with serious diseases and developmental dis-orders like 'nervous system disorders', 'immune system suppression', breast and other cancers' 'reproductive damages', 'impairment of brain development in children'

and 'disruption of hormonal systems'

Rising greenhouse gases inducing global warming and climate change: Invitation to severe natural disasters

CO_2, the major greenhouse gas inducing global warming was 280 ppm in the pre-industrial times and now stands at 370 ppm, 30% higher. It is currently rising by 0.5% every year. Powerful greenhouse gases e.g. methane and nitrous oxide are emitted from solid waste management programs by composting or more from waste landfills. Molecule to molecule, CH_4 is 20 to 25 times more powerful and N_2O is 296 to 310 times more powerful GHG than carbon dioxide (CO_2). Every 24 h, human activity on earth generates some 16 million tons of greenhouse gas CO_2 and release into the atmosphere. Coal power plant gives out about 800 to 1000 g of CO_2 for every unit (kWh) of electricity produced. In one year, an average car emits 4.3 tons of CO_2. Agriculture has also been responsible for huge emissions of greenhouse gases and induction of global warming. Of the increase of atmospheric carbon over the last 150 years, about a third (33.3%) is thought to have come from agriculture. Over the last century, the world has warmed between 0.3 and 0.6°C. If emission of all the GHG are not arrested the world will on average be 1.3°C warmer by 2020. Global warming disturb rainfall patterns, 'suppress human immune system' and induce natural disasters.

Mounting human wastes on earth: Poisoning the soil, air and water

MSW is mounting on earth everywhere. In U.S., each sunset sees a new mountain of nearly 410,000 tons of garbage. The European Union throws away an estimated 2 billion tones of MSW each year. The character and composition of MSW are changing in modern techno-logical society with the non-biodegradable 'synthetic material' coming into existence. Biomedical waste constitute considerable portion of MSW, 10% is 'infectious' and 5% is non-infectious but potentially toxic and radioactive. Several toxic chemicals are used in modern homes, resulting into generation of household hazardous waste, which are mixed and disposed with the MSW ending up in landfills with serious consequences for environment and society. The 'electronic waste' has become serious problem. It is like 'tsunami' of 'e-waste' in world. It is virtually a chemical waste mixed with general MSW ending up in landfills. Waste landfills emit more powerful greenhouse gases (Methane and nitrous oxides) and toxic trace gases like 'xylene' and 'toluene' and toxic leachate that can contaminate groundwater. In 2005 waste landfills in Australia emitted some 17 million tons CO_2-e (equivalent) of greenhouse gas equivalent to the emissions from 4 million cars. Every 1 kg of solid waste diverted from landfills prevents 1 kg of greenhouse gas emission equivalent to CO_2.

Depleting stratospheric ozone shield: Exposing mankind to radiation hazards

Hole in the ozone shield in the stratosphere over the Antarctica is growing larger and deeper, exposing man and other species to increased levels of harmful UB-V radiation. Some 66,000 tones of ozone depleting chemicals are released into the environment every year due to human activity. Increased UB-V radiation can cause suppression of human immune system making people vulnerable to infectious diseases. It can cause non-melanoma skin cancers and blindness from juvenile cataracts worldwide;

VULNERABILITY OF THE HUMAN SOCIETY ON EARTH – HOW SUSTAINABLE IS OUR FUTURE?

N-nitrosodimethylamine (NDMA), a principal ingredient in rocket fuel and methyl tertiary butyl ether (MTBE), a gasoline additive were discovered in surface and ground water sources; thousands of kilometers away from where they were used. DDT and PCBs were found on poles, thousands of kilometers away from where they were produced; radioactive isotopes strontium-90 (Sr^{90}) and cesium-137 (Cs^{137}) which are routine emissions from all nuclear power plants were found in the bone marrow of children in India far away from the sources of their emissions. All these chemical and radioactive contaminants followed the air routes to reach those distant destinations. From the atmosphere they precipitated down to Earth and entered into the human ecosystem. This shows how vulnerable we have become in the wake of material development and also pose a major question on how much sustainable is our future on Earth (Meadows et al., 1992).

GLOBAL MOVEMENT FOR SUSTAINABILITY

First UN Conference on Human Environment, Stockholm, Sweden, 1972

The first ever World Conference on Human Environment was held in Stockholm in June 1972 where representatives from more than 70 countries participated and pledged to save the environment. This may be regarded as the '1st Earth Summit'. The Conference was chaired by Mrs. Gro Harlem Bruntdland the then Prime Minister of Norway who was later entrusted with the task of forming the 'World Commission on Environment and Development' (WCED) in 1987 where she conceived the

term 'sustainable development'.

At Stockholm, the world leaders declared – "Man is both creature and moulder of his environment, which gives him physical sustenance and affords him the opportunity for intellectual, moral, social and spiritual growth. Both aspects of man's environment, the natural and the man-made, are essential to his well-being and to the enjoyment of basic human rights, the right to life itself".

Bruntdland commission report on sustainable development (1987)

The report of the 'World Commission on Environment and Development' (WCED) was published as '*Our Common Future'* (WCED, 1987). It redefined the concept of development which should encompass three components:

1. A systems of socio-economic development to meet the 'needs' (but not the 'greed') of the present generation without compromising with the abilities of the future generations to meet their own needs.
2. A system of stable socio-economic and ecological development that should improve the total quality of all life (human beings, plants and animals) on Earth now and in the future too, while maintaining the social and ecological integrity (natural and man-made ecosystems) of the earth upon which all life depends.
3. A system of socio-economic development which can provide good quality of life to all the people (rich and poor, men and women, adults and children) born on Earth, while protecting their basic life-support systems (air, water, soil, flora and fauna) and also safely disposing all the wastes (domestic, commercial and industrial) generated by them (Label et al., 1987, Goodland and Serafy, 1991).

UN Conference on Environment and Development, Rio de Janeiro, Brazil, 1992

The UN Conference on Environment and Development was held at Rio de Janeiro, Brazil, in 1992. This was the '2nd Earth Summit' organized 20 years after Stockholm and was participated by 172 countries (more than twice that participated at Stockholm). 'Environment and Sustainability' and 'Sustainable Development' was the focus of discussion. The world leaders declared – *"Human beings are the center of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature*".

The Agenda 21 (agenda for the 21st century) was adopted at UNCED. It was the blueprint for global sustainable development. Agenda 21, pronounced that "*Humanity stands at defining moment in history. We are* confronted with a perpetuation of disparities between and within nations, a worsening of poverty, ill health and illiteracy, and the continuing deterioration of natural ecosystems on which we depend for our well-being". However, integration of environment and development concerns and greater attention to them will lead to the fulfillment of basic needs, improved living standards for all, better protected and managed ecosystems and a safer more prosperous future. No nation can achieve this on its own but together we can in a global partnership for sustainable development'.

Agenda 21 cautioned that the growing population and poverty in the developing countries and the unsustainable pattern of consumption in the developed industrialized countries would thwart the spirit and pace of sustainable development throughout the world. For 'environmental sustainability', 'socio-economic prosperity' and 'environmental literacy' of the global human society, and 'political stability' throughout the world should be a pre-condition. Poor and the deprived people, and the politically discriminated would violate all economic and ecological imperatives in order to survive (because survival is more important than sustainability) thus leading to unsustainability. Highly educated can be 'environmentally illiterate' and fail to realize the importance of sustainability.

3rd World Summit on Sustainable Development (WSSD), Johannesburg, S.A., 2002

The WSSD (2002) was held at Johannesburg, South Africa to take stock of the situation about the achievements made towards attaining sustainability in the field of human development during the last 10 years since the 2nd Earth Summit in 1992. The task at Johannesburg was to recapture the momentum of the movement for sustainability begun at Stockholm (1972) and Rio (1992).

In the 10 years between Rio (1992) and Johannesburg (2002), critical environmental problems such as greenhouse gas emission (global warming), loss of old growth and primary forests (biodiversity erosion), ocean plunder and waste of resources (piling waste), lurched from bad to worse. On the socio-economic front, the rich and the powerful got richer and more powerful, while the poor became poorer and weaker. The concept of 'sustainable development' and the much lauded movement for sustainability remained on paper.

These are some of the disheartening episodes of the efforts made towards achieving global human sustainability:

1. Two billion people currently do not have access to modern energy services;
2. About than 1.1 billion people globally do not have access to safe drinking water. It is predicted that water

supply will be the major constraints on sustainable development in the 21st century.
3. About 2.4 billion people lack adequate and improved sanitation;
4. More than 1.2 billion people still live on less than 1 dollar (IR 40.0) a day, that is, much below the poverty line;
5. More than 3 million people die of air pollution, and the same number dies from diseases caused by unsafe and polluted water. The target of 'Health for All by the Year 2000' never became a reality.
6. New highly toxic chemicals' e.g. N-nitrosodimethylamine (a principal ingredient in rocket fuel), methyl tertiary butyl ether (a gasoline additive), and 'acrylonitrile' (used in textile industry) have appeared in surface and ground water;
7. Half of the tropical rainforests and mangroves (treasure of pristine biodiversity) have already been lost;
8. About 75% of the marine fisheries have been fished to capacity;
9. In September 2000, the ozone hole over Antarctica covered more than 28 million square kilometers;
10. Some 75 billion tones of 'top soil' are eroding every year. Around 2 billion hectares of soil, 15% of Earth's land is now classed as degraded (WHO, 1997; UNDP, 2004; Steffen et al., 2004).

Report of the Global Environmental Outlook (GEO)-3 on sustainability

The planet is at 'critical crossroads' concluded the UNEP's '*Global Environmental Outlook 3*' report (GEO-3). The study, collaboration between UNEP and some 1,000 individuals and 40 institutions around the world is the most authoritative assessment to date of where we (the *Homo sapiens*) have been, where we have reached, and where we are likely to go. GEO-3 shows how far the world has gone on the road to sustainable development since the Rio Earth Summit 1992. It said that though the world has made great strides in placing environment on the global developmental agenda, the twin evils of 'poverty' (in the developing world) and the 'excessive consumption' (in the developed world) due to too much of 'prosperity' continue to put enormous pressure upon it. Dire poverty and environmental degradation feed on each other. Ironically, growing poverty all over world is the main stumbling block on the road to environmental protection and sustainable development (UNEP-GEO, 2004-05).

People's mandate on sustainable development

Several opinion polls were conducted on the eve of Johannesburg Summit (WSSD, 2002) by international agencies to know the views of people across world and assess their awareness on the question of environmental sustainability built up since the Rio Earth Summit in 1992. Market and Opinion International (MORI) polled in 30 countries containing two third of world's population and found that 91% people in Greece, above 60% in the U.S., Germany, Russia, France, Italy, Spain, Japan, Mexico, Brazil, Chile, the Republic of Korea and China, and about 54% in India wanted legal protection for the environment through legislative actions. Some 69% people in U.K. agreed that environmental degradation especially waste and pollution is affecting their daily life.

Opinion poll by Roper Worldwide found that 39% people in these 30 countries were of the view that environmental protection and sustainable development was of paramount importance today. The percentage of people expressing this view was significantly higher in India, Argentina, the Philippines and Germany. Gallup Polls made in the U.S. found that 57% Americans were more concerned about pollution of rivers, lakes and streams while 29% cited fears about global warming. (Yet the U.S. has not signed the Kyoto Protocol). In another poll, 65% Americans saw erosion of biodiversity as the most serious problem facing the humanity. The MORI Millennium Poll wanted to know from people which section of the society was mainly responsible for the environmental degradation and the responsibility for its repair and restoration. Almost 6 in every 10 asserted that the 'corporate sectors' were mainly damaging the environment to make profit even at the cost of environment, and hence protection of environment was their moral responsibility. Indians also said that the company's and industries must bear responsibility of environmental repair. But in the U.S., a majority of people asserted that environmental protection was government's core responsibility and 90% of them wanted information on companies environmental and social records. 49% of the Europeans surveyed said that they would NOT buy a product made in a country with poor environmental and social standards (UNDP, 2003, 2004).

Opinion polls clearly show that people worldwide realize the importance of environmental protection and sustainable development for their existence and put the blame mainly on the corporate sectors specially the transnational corporations (TNCs) for all the environmental evils.

THE STRATEGIES FOR SUSTAINABLE DEVELOPMENT

Planning for sustainable development is like 'preventing' a disease to occur in the first place. As prevention reduces the chances of individual suffering from the disease, so does, environmental planning and management for the whole society. It would significantly reduce, if not completely prevent, the risk of environmental damage and the sufferings of the society caused due to it. At least, it will prevent any major 'environmental disaster' which struck the human society in the past (Sinha, 1994).

Sustainable development will deliver social, economic and ecological benefits, for it will conserve resources, reduce waste, prevent loss of energy and protect human health. The World Business Council for Sustainable Development (WBCSD) was formed in 1995. It is a coalition of 120 international companies that have a shared commitment to protect the environment through cleaner production and waste minimization in industries (Schmidheiny et al., 1997).

Seven pillars of sustainable development

The new paradigm of development is not the game of economics alone. All issues- economic, ecological, social (health), cultural (educational), legal (legislative), political and technological have to be merged into a collective decision making for sustainable development. They are mutually reinforcing. Technology plays greater role as they drive development (Axinn, 1996).

Earlier economy was at the center of decision-making. This assumed that all environmental problems could be solved if economy was sound. This has now become an obsolete theory. Now ecology has to be at the center. We have to integrate ecological thinking into social and economic planning. The developmental activities have to be 'economically viable', 'ecologically compatible', 'socially equitable', 'culturally acceptable' and 'politically justifiable'. Then only it can be environmentally sustainable. This will require giving up the 'culture of consumerism', 'producing fewer consumers that the Earth can sustain and also achieving 'equity in resource use and consumption' across the world. Over-consumerism and too much of prosperity in one part of the world, or overpopulation and poverty in other part, would thwart the spirit of sustainable development.

The most important sustainability issue today is to save and protect the very life-support systems (air, water, food and soil) and the biodiversity, protect human health, arrest global warming and depletion of stratospheric ozone shield, arrest desertification, augment clean energy and material resources to continue and maintain the pace of development, and to safely dispose all the wastes generated by the society.

What we need to sustain

1. The ecosystems and the accompanying biodiversity with the variety of species and their habitats;
2. The natural capital of earth e.g. the stock of productive soils, forest and the fresh water and all the non-renewable resources by preventing their unsustainable use;
3. The ecological integrity of earth and the resilience of natural life-support systems by maintaining an adequate number of primary producers;
4. The social integrity of earth by maintaining an acceptable level of non-consumerist population (secondary consumers) within the ecological limits and the 'carrying capacity' of earth (IUCN, WWF, UNEP, 1991).

THE TECHNOLOGICAL PERSPECTIVES FOR SUSTAINABLE DEVELOPMENT: DEVELOPMENT OF ENVIRONMENTAL TECHNOLOGIES

Science and technology came as a 'mixed blessing' for mankind. It brought peace and prosperity, comfort and facility, health and wealth for mankind through rapid utilization of the natural resources. It provided all the basic amenities of life and fulfilled all the human aspirations – copious amount of energy to drive all developmental activities and provides comforts of life, a good and secured dwellings to live and durable clothes to wear, a rapid means of transport and quick means of communication, nutritious foods to eat, clean water to drink, prompt healthcare and sanitation facilities, a system of weather forecast and advance warning system for coping with natural disasters and genetic engineering for improving the economic value of useful plants and animal species.

When used judiciously and legitimately for human development, science saved life and property, but when 'misused', it spelt disaster. Technology practically transformed the 'traditional human society' which was more vulnerable to the vagaries of nature, more dependent for survival on nature, less adapted to survive against odds, to 'modern human society' which is less vulnerable to the vagaries of nature, more fit to survive in difficult situations, less dependent on nature for survival and more competent to manage their affairs.

Technology is the backbone and driving force of sustainable development. However, unfortunately some of the technologies of the early 20th century proved to be a 'curse in disguise'. They triggered the pace of economic development by indiscriminately using the scarce resources, and generated huge amount of waste and pollution undermining the very resource base upon which development was to be made. Towards the end of the last century when human environment specially the life-support systems air, water, soil and the natural ecosystems started showing signs of degradation that the scientific community realized that something wrong was going with the existing technologies used in the development process. This necessitated the development of more 'appropriate technologies' for human development which has been termed as 'green technologies' or 'sustainable technologies' (Adams, 2001).

Technological developments (environmental technologies) in the past decades and especially after the1980s have delivered spectacular improvements in the environmental quality, cleaner air and water, low

emission automobiles, less toxic and hazardous wastes, water and energy efficient homes and appliances etc. Some of the remarkable technological achievements of the 20th and 21st century marching towards sustainability are:

1. A significant reduction in the air borne lead (Pb) has been achieved by developing 'Lead Free Petrol' and use of Natural Gas and Ethanol as auto-fuel.
2. A considerable reduction in the emission of CO, HC and NOx by modification in the IC engines, by installation of 'catalytic converters', and introduction of direct fuel injection and 'lean-burn combustion technologies'.
3. More fuel efficient, quieter and less polluting automobiles driven on environmentally benign auto-fuels like compressed natural gas (CNG), liquidified petroleum gas (LPG) and ethanol, less body and wheel weight and aerodynamic bodies to induce less resistance to wind. Hybrid-vehicles are also quiet and much less polluting. Hydrogen fuel which is 4.5 times powerful than petrol with 'zero emission' (only water vapor) makes a big promise for a sustainable future. U.S., Germany and China are ahead. BMW, Germany has several fleets operated on hydrogen. Iceland also has buses running on hydrogen fuel.
4. Development of more energy efficient electrical appliances and instruments such as automatic lighting control system (ALCS), compact fluorescent light bulbs, low voltage tungsten halogen and sodium lamps etc. They save electricity from 70 to 80%. Modern ACs, fridges, washing machines, dishwashers use 75% less energy than older models. Reverse cycle AC (for cooling and heating) use 67% less electricity, rheem pump hot water system (using air to heat water) use only 60% energy. Electric stove with fan forced oven are 30% more efficient than conventional electric stove. Gas stoves are much more energy efficient and microwaves uses 55% less electricity. Compact fluorescent lamps use 70 to 80% less electricity for same light with 8 times longer life and prevent emission of nearly a ton of GHG in its lifetime (Energy efficient appliances and instruments have reduced the emission of greenhouse gas carbon dioxide (CO_2) in the same proportion).
5. Development of eco-efficient water appliance. A significant reduction in the waste of potable water has been achieved by developing 'automatic closing taps', 'water efficient showers' and 'dual-flushing cisterns' in the bathrooms and toilets and development of 'sprinkler and drip irrigation' systems in agriculture. New bathing shower uses 9 to 16 L of water per minute as compared to 20 to 30 L used by inefficient showers. The dual-flush cistern saves 6 L of water each time in urinal flushing. New cloth washing machines and dishwashers are very efficient in water use. Drip and sprinkler systems saves40 to 60% of fresh water in farming.
6. Development of 'clean coal technology' by generation of clean coal seam gas (methane) through underground combustion on coal beds and reaction with hydrogen is a brilliant new idea to utilize the huge coal reserves of world. It is like 'using coal without mining'. Australia is pioneering in the technology. It also utilizes 90% of coal as compared to hazardous conventional mining which only utilize 60%. This has led to significant reduction in the emission of greenhouse gas carbon dioxide (CO_2) and other toxic pollutants. Methane is piped out and supplied to power plants for electricity generation.

The 'flue-gas desulfurization technology' in conventional coal power plants has also led to significant reduction in sulfur dioxide (SO_2) emission which causes acid rains. More efficient air pollution control equipment and devices such as 'electrostatic precipitators', 'bag filters' have also been developed for conventional coal power plants.
7. Natural gas, micro-hydel, solar, wind, tidal and geothermal power projects for electricity generation has also come up successfully in world and significantly reduced pollution and greenhouse gas emission. More efficient WIND TURBINES has been developed and they perform very high along the seashore of world. Denmark is generating over 90% of its electricity need through seashore wind turbines.

The 'solar photo voltaic cell technology' has brought a revolution and a new era in economic 'lighting and heating' devices and reduction in greenhouse gas (CO_2). PV system is now used on large scales in domestic, industrial and commercial sectors especially in both urban and rural areas. China is leading in solar power generation. Australia is also coming up fast in a revolutionary way supported by Govt.
8. Development of technologies for recycling of metals, glasses, papers and cardboards, and tough plastics to get back those materials for reuse in society. It avoids mining of ores of metals and the associated environmental hazards, protects trees from cutting to make 'pulp' and saves huge amount of freshwater and energy in their production from virgin materials while also reducing emissions of greenhouse gases. Production of plastics from 'synthetic organic chemicals' is also hazardous process.
9. Partial plugging of the 'ozone hole' in the stratosphere has been achieved by developing lesser evil substitute hydrochloroflurocarbon (HCFC) which has 30% less ODP than CFC, and large part of it is destroyed in the atmosphere before reaching the stratosphere.
10. In the polystyrene foam manufacturing industry 'carbon dioxide' is being used as the 'blowing agent' replacing CFC. The new technology has eliminated 3.5 million pounds of the dangerous ozone depleting and global warming chemical chlorofluorocarbon (CFC) every year.
11. In the paper pulp industry an environmentally benign oxidant 'hydrogen peroxide' is now being used as the bleaching agent replacing the dangerous 'chlorine'.
12. An environmentally benign non-ionic and

biodegradable surfactants called 'alkyl glycoside' made from saccharide has been developed to replace the non-biodegradable anionic 'alkylaryl sulphonate' used in shampoos.
13. 'Sodium silicate' is now used as an environmentally benign alternative to the phosphorus-containing additives in washing powder.
14. Hybridization technology and 'agri-biotechnology' (ABT) has produced high yielding varieties (HYVs) of crops (miracle maize, miracle rice and miracle wheat) which tripled and even quadrupled food production on the same available land area thus increasing agricultural sustainability.
15. A new environmentally friendly technology called 'catalytic dehydrogenation of diethanolamine' has been developed in herbicide producing industries that avoids the use of toxic chemicals cyanide and formaldehyde.
16. Biological control of pests and diseases in agriculture has become more effective after scientific improvement of the herbal pesticides like 'azadirachtin' and 'pyrethrin', and development of 'transgenic crops'. Use of earthworms vermicompost also repels and suppresses 'pests' and 'diseases' by over 80% in crops due to the presence of 'chitin' and cellulose degraders microbes. The fermented solution of vermi-compost called 'vermicompost tea' and the liquid filtered through the body of earthworms called 'vermiwash' is an effective biopesticides.
17. Development of biodegradable 'agro-plastic'. It carries great significance for the environment and society. It is the cheapest and most convenient material ever known to mankind.
18. The 'membrane filtration technology' by 'reverse osmosis' is most significant new development of water and wastewater treatment without the use of chemicals. It can produce 'high-quality disinfected water'. It can remove several chemicals (VOCs, MTBE, NDMA, several endocrine disrupters) and endospores and cysts of pathogenic bacteria and protozoa not removed by conventional methods.
19. The 'dematerialization technology' is a significant new development. It leads to reduction in the use of materials (in weight) and energy (in MW) over in all industrial goods and products while fulfilling the same services. It has reduced the use of environmental resources (metals and glasses) and synthetic plastics by more than 20 to 25% in the manufacture of containers, cans and bottles and consequently the energy used and greenhouse gas emitted in their manufacture, and also the quantity of wastes generated after their use and discard. Steel beverage cans have been downsized by 40% since 1970. It saves materials and reduce mining activities which has severe impact on environment.
20. Development of eco-efficient non-mineral materials which can replace natural resources of earth in development and reduce mining. Ceramics, carbon and glass fibres and alloys of aluminium and lithium are new materials with superior technical properties; ultra strong and light weight. Automobile and aircraft industries are using carbon fibres instead of steel to reduce weight and improve fuel efficiency. Use of steel is reduced by 25%.
21. Eco-designing of products to reduce material use and improve efficiency. Ferrocement technology' was developed in India. It use much less cement and steel, has higher degree of toughness, durability, ductibility, tensile strength and crack resistance in less than 25 mm of thickness, which is found in 100 mm thick wall of conventional RCC Technology.
22. Development of sustainable environmental biotechnologies for municipal and industrial waste treatment, waste reduction, reuse and recycling (converting waste into resource), diverting huge volumes of solid wastes from going to the landfills every year and saving land, cost of transport and landfill construction, and emission of greenhouse gas methane (CH_4) from landfills. The most significant development is the global revival of 'vermiculture biotechnology' with scientific use of some versatile waste eater and chemically tolerant earthworms species like *Eisenia fetida, Perionyx excavatus and Eudrillus euginae* whom the great visionary scientist Sir Charles Darwin called as *'unheralded soldiers of mankind and friends of farmers*'. They are 'protective', 'productive', 'disinfecting', 'detox-ifying' and 'neutralizing' (Sinha and Greenway, 2004).

The sustainable vermiculture biotechnology

Globally six (6) environmental biotechnologies have been identified for sustainable development by scientific use of earthworms:

(1) The vermi-composting technology for efficient management of most municipal and industrial organic wastes including sewage sludge by biodegradation and stabilization and converting them into vermicompost (nutritive organic fertilizer). Earthworm participation enhances natural biodegradation and decomposition of organic waste from 60 to 80% given the optimum conditions of temperature (20 to 30°C) and moisture (60 to 70%). It takes nearly half the time to convert waste into compost and the process becomes faster with time as the army of degrader worms grows.
(2) The vermi-filtration technology for treatment of municipal and industrial wastewater, purification, detoxification and disinfection for their reuse. Earthworms body work as a 'bio-filter'. They can remove the BOD_5 by over 90%, COD by 80 to 90%, TDS by 90 to 92%, the TSS by 90 to 95% and the total coliforms by over 99% from wastewater. There is no sludge formation which plagues all the conventional treatment plants. Worms also remove the dangerous 'endocrine disrupting chemicals' from sewage which cannot be done in the

conventional systems. All the end-products (detoxified and disinfected nutritive water, vermicomposted sludge and huge earthworm biomass) are useful in agriculture.
(3) The vermi-remediation technology for land remediation by removing chemical contaminants from soils and reducing soil salinity while also improving the total physical, chemical and biological properties of soil and its nutritive value. Earthworms have been found to bio-accumulate heavy metals, pesticides and lipophilic organic micro-pollutants like the polycyclic aromatic hydrocarbons (PAH) from the soil. Significantly, vermiremediation leads to total improvement in the quality of soil and land where the worms inhabit and make them highly productive. They swallow large amount of soil every day, grind them in their gizzard and digest them in their intestine with aid of enzymes. Only 5 to 10% of the digested and ingested material is absorbed into the body and the rest is excreted out in soil in the form of fine mucus coated granular aggregates called 'vermicastings' which are rich in NKP (nitrates, phosphates and potash), micronutrients and beneficial soil microbes including the 'nitrogen fixers', 'phosphate solubilizers' and 'mycorrhizal fungus'. Hence the polluted land is not only 'cleaned-up' but also 'improved in quality and fertility'. The soil becomes lighter and porous biochemically active and the productivity is increased to several times. During the vermi-remediation process of soil, the population of earthworms increases significantly benefiting the soil in several ways. A 'wasteland' is transformed into 'wonderland'.
(4) The vermi-agro-production technology for restoring and improving soil fertility and significantly boosting crop productivity. Vermicompost is a highly nutritive 'miracle growth promoter'. Growths and yield of crop plants are enhanced by 30 to 40% higher over chemical fertilizers by worms and its vermicast. Studies at CSIRO Australia found that the earthworms and vermicompost can increase growth of wheat crops by 39%, grain yield by 35%, lift protein value of the grain by 12% and fight crop diseases. Vermicompost also increases 'biological resistance' in plants and protect them against pest and diseases either by repelling or by suppressing them. Organically grown fruits and vegetables on vermicompost have also been found to be highly nutritious, rich in 'antioxidants' and can be highly beneficial for human health even for protecting against 'cancers' and 'cardiovascular' diseases.
(5) **'**The vermi-health protection technology' by the use of 'bioactive compounds' from earthworms to develop 'potential modern medicines' to combat some chronic and deadly diseases like 'cancers', cure 'heart diseases' and protect human health. The earthworm's 'anti-oxidant', 'anti-microbial', 'anti-cancerous', 'immune-boosting' and 'clot dissolving' medicine chest is so powerful as that of any plant and even many pharmaceuticals.
(6) 'The vermi - industrial production technology' for use of earthworms to produce some valuable industrial raw materials. All species earthworms are potential source of 'biological raw materials' for production of useful 'biodegradable' industrial products in rubber, lubricant, soaps, detergent and cosmetics industries and also as valuable source of 'proteins' for production of 'nutritive feeds' for promoting allied 'food industries' like fishery, dairy, poultry and piggery for meat and milk production.

We have successfully experimented on vermi-composting, vermi-filtration, vermi-remediation and vermi-agro-production technologies at Griffith University, Australia with excellent results. They are proving to be most cost-effective and cheap environmental biotech-nologies for 'environmental management and sustainable development'. Huge earthworm biomass which is finding new uses in industries and agriculture comes as byproduct in all above technologies. They all have significant contribution towards 'sustainable agriculture'. Vermifiltration of wastewater was our innovative studies done in 2005 and the technology has now been commercialized in India by Transchem Agritech in Gujarat. They are treating 400 kl of sewage everyday and the treated water is being supplied to farmers for use in agriculture saving huge amount of potable water. Nearly 80% water is used in global agriculture. Several Vermi-filtration plants are also operating in Chile, Mexico and Venezuela for treatment of municipal and industrial wastewater (This was based on the works done by Prof. Toha and Dr. Soto of University of Chile).(masoto@cec.uchile.cl).

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Telecommunication and information technology contributes to sustainability

Telecommuting is a new concept of working from home using PCs and electronic links. It reduces the need to drive to work preventing emissions and congestion in cities, the need to heat or cool and light big offices which again saves energy and cuts emissions. More than half of the managers of AT & T Telecom Company in the U.S. telecommute one day a week, reducing 80,000 tons of carbon dioxide annually due to reduced travel and transport (UNEP Report, 2002). Several official works/business including banking and money transfers can now be done over telephone or through the internet saving travel distance, time and resources. Similarly live 'videoconferencing' instead of face-to-face talk in official meetings is another emerging environmentally friendly idea. It reduces the need of transport, often long travel distances and times (even visit to overseas) and significantly cuts pollution and carbon emissions while saving resources. However, the boom is communication and information technology has also brought in large amount of electronic products whose generation (version) is fast changing, resulting into their rapid use and discard as electronic wastes.

Development of more green technologies for sustainable development

Environmental technologies have to find solutions for both 'preventive' as well as 'curative' actions for the environmental degradation. It has to protect the vital life support systems of the planet Earth – the air, water, soil and the ecosystems, and also manage all the wastes generated by the civilization. It must promise to deliver clean air, safe food, safe water, clean energy, sustainable dwelling and a sustainable transport system for the civilization. More appropriate and sustainable green technologies need to be developed in future for environmental protection and conservation, restoration and repair in the following priority areas of human development to achieve complete sustainability for the human society:

1. Commercialization of clean hydrogen fuel for automobiles, and solar, wind, geothermal and oceanic energy for utility power generation.
2. Making the conventional energy (fossil fuels and hydropower) sources more clean and green and thus more sustainable.
3. More efficient energy use and conservation in homes, institutions and industries.
4. Cost-effective technology for water and wastewater (both municipal and industrial) treatment.
5. More efficient water use and conservation in homes, industries and agriculture.
6. Cleaner production in all mining, manufacturing and consumer industries to reduce and even prevent the use of toxic chemicals in production process and eliminate their emissions in wastes.
7. More recycling technologies for all municipal and industrial wastes, for their safe disposal and conversion into valuable resources.
8. Methods for 'safe disposal' of existing non-biodegradable plastic wastes, and development and commercialization of 'biodegradable plastics'.
9. More dematerialization technology to increase the efficiency of natural resource (metals and glasses) use and plastic use and reduce their waste.
10. Environmental biotechnology and bioremediation technologies. They are emerging as most cost-effective technologies for environmental management- solid waste and wastewater treatment, conversion of organic wastes into resource (biofertilizers and biopolymers), stabilization of mined wasteland, decontamination of chemically contaminated sites, safe disposal of hazardous wastes, and soil conservation and erosion prevention etc.

THE SOCIAL PERSPECTIVES FOR SUSTAINABLE DEVELOPMENT

The social components of the environmental management and sustainable development is as important as the economic and technological (Lovins et al., 1999).

Technology has provided efficient low-emission vehicles, but what if people continue to drive unjudiciously and unethically; technology has provided energy efficient bulbs, air-conditioners and appliances, but what if people do not buy them as they are more costly or carelessly leave them switched on even during day time and when not needed; technology has provided water efficient taps and showers, but what if people carelessly take longer shower than actually needed, fails to close the tap in-between brushing or shaving, or leave the leaking taps unattended; technology has provided solution to complete waste treatment, waste reduction, reuse and recycling, but what if the industries choose to dump the untreated wastes because treatment or recycling may be more costly than disposal? Similarly what if the society does not cooperate in separating the recyclable wastes from the non-recyclables at source?

Technological process and products that promote sustainability are often costly than the contemporary articles that serve the same purpose and provide the same service. Energy efficient fluorescent lights are much more costly than the ordinary filament bulbs; the fuel efficient and reduced emission hybrid cars are more costly than several other models with same facilities.

General human nature is to buy cheaper products even if it is harmful to the environment and as long as it meets the social and cultural objectives nicely. Hence not only the green technologies have to be cost-effective, their products have to be cheaper too, so that everyone can afford easily and reasonably.

Guarantee for human rights

Economic development and environmental protection require social development – efforts to promote and protect internationally guaranteed civil, political, economic, social and cultural human rights. Neither economic development nor environmental protection can be fully assured in the absence of respect for fundamental rights and freedoms.

Certain human rights- such as access to health and environmental information about the diverse consumer products being used in day to day living (especially about the chemicals used in their production process), information about the environmentally safe quality of land, air and water being used by the society, raising voice against any form of environmental degradation (e.g. tree logging, air, water and noise pollution) in the locality, public participation in governance and redress for any environmental harm- may be very important in achieving sustainable development.

Sustainability education for the modern technological society

Environmental education for sustainability is fundamental

to the success of sustainable development programs (Fien, 2001). *Societal response to environmental issues is often slow as compared to the responses to economic issues such as price rise or health issues such as spread of disease.* The society has to be educated to 'demand' and also 'accept' a particular technology and the technological product which is 'environmentally friendly', or 'reject' all those products which are 'environmentally unfriendly', and then only the industries will be encouraged or even compelled to produce environmentally friendly products. Society has to be educated about the judicious and sustainable use of the 5 Ps (paper, petrol, potable water, power (electricity) and plastics) in their daily- life. These are the most commonly and most frequently used resources by the society everyday and their production and use has considerable environmental impact. Society has also to be made aware about the hidden dangers of environmentally unfriendly products and the adverse impact of their use on human health. They must know their 'environmental rights and responsibilities', what is good or bad about environment, which sustain their life on Earth.

Educating for environmental responsibilities of society: Sustainable consumption by rich society can lead to universal sustainable development

At the root of the entire environmental problem is the unethical increase in the 'culture of consumerism' in the developed nations, while the unethical increase in the 'number of consumers' (population) in the developing nations. There is also a growing tendency for increasing consumerism in the handful of elitist societies in the developing nations. The environmental impact of both of this cultures, are exceeding the 'ecological limits' and the 'carrying capacity' (regeneration of renewable resources and assimilation of all wastes) of the Earth ecosystems with severe consequences for the future.

Global consumption expenditure, private and public, has increased at an unprecedented rate worldwide but more in the rich developed nations, since the 1970s reaching some US $ 24 trillion in 1998 (UNEP-DTIE, 2002). This unprecedented growth in consumption (rather over-consumption) in affluent societies of developed nations (and handful of elitist people in the developing nations) has had positive impact as it promoted the growth of consumer industries, but highly negative impact on the environment as more consumption meant more extraction of environmental resources leading to more deforestation, soil degradation, waste and pollution, biodiversity erosion and social inequality. The adverse impacts were felt more in the developing nations where a vast majority cannot afford and suffers from 'under-consumption' and inequality. They provided some of their precious developmental resources (geological and biological for dollar earnings) and were also made the 'dumping grounds' of the by-products (often hazardous wastes) of over consumption in developed nations.

Governments in developing nations nurse serious misgivings that the developed nations having followed the culture of 'over-consumerism' for several decades, and now wants to deprive the developing nations from their legitimate right to develop and consume in the name of environmental protection and sustainable development. In 1998, UNEP's Division of Technology, Industry and Economics (DTIE) launched a 'Sustainable Consumption Program' and tried to dispel the misgivings about reducing consumption worldwide. It emphasized "Sustainable consumption is not about consuming less but it is about consuming differently, consuming efficiently, consuming judiciously, and having an improved quality of life for all, (not for handful of few) both in the developed and the developing countries. It also means sharing between the rich and the poor" (UNEP-CDG, 2000).

Awareness for green consumerism in society: A sign of hope for sustainability

Companies in developed nations are also beginning to take notice of the growing numbers of 'green consumers' in society as awareness about environmental health grew worldwide (Eklington and Hailes, 1989). Global consumer opinion seems heavily weighted towards a growing interest in what lies behind today's product and services that they buy. Apart from price and quality, they want to know how, where and who has produced the product. They want to know what chemicals are there in the product, which can have even a suspected impact on health. This increasing awareness about environment and health in human society is a sign of hope for a sustainable future. Government and industry must build on that.

Social equity, reduction of population and eradication of poverty: A necessary condition for sustainability

Sustainability refers not only to the natural environment but also to the social environment because social and environmental issues are necessarily inter-wined. Some societies have benefited most by new technological development and unsustainable use of resources while others have suffered. There is a nexus between 'Poverty and Pollution', between 'Population and Poverty' and between 'Population and Pollution'.

Nearly 930 millions of people (consumers) are being added every year to the earth demanding more of all resources, more forest to produce food and fuel, and more land to live. If this consuming population is affluent it would further aggravate the problem of unsustainability. Hence we must have a sustainable level of population

that the earth ecosystem can reasonably support. Technology used to harness the resources from the biosphere plays a critical role in resource use and sustainable development. More appropriate and efficient a technology, more efficiently the resource will be used, lesser will be the waste and pollution generation and greater will be the sustainability.

The goals of sustainable development cannot be achieved unless we have a new world order with equity at all levels; social, economic, political and cultural. Till the evils of 'poverty and hunger', 'inequities and 'deficiencies' exist in any part of world, there can be no sustainability in development. Social and economic equity is a necessary condition for sustainable human development. If the rich get richer and the poor becomes more in number, that development will not be sustainable over time. If development discriminates against the women and children, that development will also not be sustainable.

There is mounting evidence that environmental degradation and economic decline (aggravating poverty) feed on each other, and the fate of the poor and the fate of the planet (Earth) have become tightly entwined "The poor are both the victims and the agents of environmental damage. They are forced to consume the environmental resources (even from the very fragile ecosystems) in order to survive, and the impoverishment of the environment leads to worsening poverty and unsustainablity". Economic deprivation and environmental degradation have thus come to reinforce each other in a vicious cycle that perpetuates poverty and destitution in many developing countries and thwarts all efforts towards sustainable development (UNDP, 2003, 2004).

Good health: A necessary condition for human sustainability

There can be no sustainable development without ensuring basic health services for all in the society. The World Health Organization (WHO) reports that 25% of all preventable illness are directly caused by environmental factors. Modern health hazards, caused by development that lacks environmental safeguards, such as urban air and water pollution, exposure to ago-industrial chemicals and toxic wastes is becoming common. Communicable diseases, especially HIV/AIDS, cholera and other water borne diseases, tuberculosis and malaria, pose serious obstacle on the road to sustainable development.

It is estimated that in this modern technological world 3 million people die every year of water borne diseases or from use of unsafe water. More than 1 billion people globally breathe unhealthy air, and 3 million people die each year from air pollution; two thirds of them poor people, mostly women and children. Two million people die every year as a result of slow exposure to indoor pollution caused by burning of wood and dung cake. Around 90% of malaria cases in the world are attributable to environmental factors; piling waste and poor sanitary conditions (WHO, 1997).

THE ECONOMIC PERSPECTIVES FOR SUSTAINABLE DEVELOPMENT

The classical economics has failed to guide true human development. Current GNP (gross national product) of nations is a false indicator of true economic prosperity. It does not distinguish between resource uses that sustain development and those that undermine it. It is like a 'malfunctioning strand' of our 'cultural DNA code' – carrying erroneous information and signaling to the body-politic a form of economic growth analogous to that of cancers cells that consume the host body. All basic biological and physical systems of earth (the true capital resources e.g. soil, water and biodiversity) that sustains life are under severe stress and in fact 'exhausting', as ecological destruction continues unabated, yet the key economic indicators shows that the world is prospering (Ekins, 1992).

Conventional economists and the ignorant politicians are not bothering to deduct the cost of environmental destruction (e.g. waste and pollution creation and their health impact, loss of forest and species, degradation of land and soil etc.) and the cost of environmental repair and restoration (e.g. afforestation, waste management and pollution control, soil regeneration and wasteland management, waste water recycling etc.) from the GNP or the rate of economic growth. All economic development programs are implemented through political decisions. The developers and decision makers have to understand that all economic development programs involves the systematic transformation of the world of 'living things' (the biosphere – or the natural world which is a product of centuries of evolutionary process) into a world of 'human artifacts' (the technosphere or the surrogate world). This means all human development process is necessarily 'anti-evolutionary', and therefore, 'anti-nature' and it amounts to gross interference into the nature to achieve the goals of economic development. It is imperative that we have to change the strategies of development in order to minimize our interference into the nature. The new economic theory is '*Environmental Economics*' which advocates for judicious balance between 'economy and ecology' and amalgamation of 'economic development' programs with 'ecological conservation' strategies to usher in the era of sustainable development. The new economic philosophy of development also stresses mankind to switch over from the 'fossil fuel based economy' to 'renewable and clean energy based economy'.

Economic planners have to understand that every natural resource, commodity, goods and services that we use from the environment has an 'environmental cost' (the hidden cost of environmental damage and repair

while the raw material is procured from the earthly resources) other than its 'economic cost' (the cost of processing, manufacturing and trading) and only after adding the two costs, we arrive at the true cost of the product. There may be 'social cost' as well in the form of impaired human health and quality of life.

Environmental damage can occur at both ends of the cycle - the 'production cycle' as well as at the 'consumption cycle'. In the production cycle environmental damage is caused by way of deforestation, earth cutting, soil erosion and pollution etc. to obtain the raw materials by mining the Earth and process it in the industries, while in the consumption cycle, the damage is caused because of waste generation once the product is consumed and discarded after use. Fossil fuels, nuclear fuels, several metals, papers and plastics and even procurement of human food and drinking water from the nature cause environmental damage at both ends of the cycle.

We only pay for the economic cost of the water (cost of harnessing and supply) when we use it in our homes. We do not pay for the treatment of the wastewater when we have used it and converted into sewage. We only pay for the cost of food grown in farms and its processing and transport. We never pay for the damage done to the environment due to production and use of chemical fertilizers and pesticides. We pay for the electricity we consume, but not for the environmental damage that occur by operation of coal power or nuclear power plants and by the construction of huge dams for hydro-power.

Classical economics only accounts for the electricity generation and irrigation potential of any hydro-power project but never takes into account the losses which incur by way of land submergence and destruction of trees, forest and biodiversity by constructing huge dams. They are not bothered to add the value of the life sustaining oxygen produced, carbon dioxide (greenhouse gas) absorbed, and biodiversity protected by the trees and forest, if they were alive? Environmental economics would account for all these. In classical economics a tree has a value only when it is dead and become a 'timber', while in environmental economics a live tree has more value as it do more services to mankind by providing food, fodder, fuel and the vital oxygen. It is important that the cost of 'environmental damage' and the cost of 'environmental repair' must be included in the economic calculations for GNP of every nation (Tietenberg, 1988).

In a pilot study in Mexico, the planners tried to measure the cost of environmental damage and resource depletion due to development. When an adjustment was made for the depletion of oil, forests, and groundwater, Mexico's net national product was almost 7% lower. A further adjustment for the costs of avoiding environmental degradation, particularly air and water pollution and soil erosion, brought the national product down to another 7%. In the agriculture and animal husbandry sector adjustment for the cost of soil erosion sharply reduced the net value added (Goodland and Serafy,1991).

The concept of circular economy: Recycling and reuse of waste and resources

The new economic philosophy is to cut the use of basic (virgin) materials from the environment dramatically, by boosting 'recycling and re-use' the waste including water, energy and materials from one facility/industries/organizations becoming an input in another facility. In circular economy, all economic activities pursue low resource exploitation, maximum efficiency in using materials and energy, and low waste generation. China, the largest growing economy in world has adopted the concept of 'circular economy'. It has set the following targets for 2010 using 2003 as baseline (UNEP-DTIE, 2002):

1. Resource productivity per ton of energy, iron and other resources increased by 25%;
2. Energy consumption per unit of GDP decreased by 18%;
3. Average water use efficiency for agricultural irrigation improved by up to 50%;
4. Reuse rate of industrial solid waste (ISW) raised above 60%;
5. Recycle and reuse rate for major renewable resources increased by 65%
6. Final industrial solid waste (ISW) disposal limited to about 4,500 million tones.

If all nations both developed and the developing, follows the philosophy of 'circular economy' with some set targets for 2010 or 2015 it will great leap forward for the global sustainable development.

Environmental auditing and accounting of developmental activities

There has to be EAA and environmental cost-benefit analysis (ECBA) of all those developmental activities and their associated technologies which sustains growth and development- such as management of domestic and industrial wastes; tree planting and afforestation activities; soil conservation, remediation and wasteland development. EAA and ECBA are needed for those developmental activities and technologies, too, which otherwise undermine growth and sustainable development- such as deforestation for timber mining and agriculture; encroachment of farmlands and old growth forest for urban development; extraction and processing of ores and minerals from the earth crust in mining and metallurgical industries; production and use of fossil fuels and nuclear fuels; construction of huge dams for hydropower generation; and production and use of agro-

chemicals for agriculture etc., so as to make these developmental activities environmentally more sustainable

Making the profit making companies more accountable for sustainable development

Opinion polls made on the eve of Johannesburg Summit (2002) clearly show that people worldwide want the companies in both private and public sectors to bear the responsibility of environmental degradation and act with greater responsibility towards its repair and restoration. The behavior of big companies and corporate sectors, and the need to make them more responsible and accountable, has captured public attention and interest in all discussions relating to environmental protection and sustainable development. Maximizing 'short-term profit' even at the cost of environment and society had been the key principle of operation of almost all companies in world whether in the developed or in the developing countries. Burning examples are the 'Petrochemical and Agrochemical Industries' of world. One has deliberately thwarted the development of 'Hydrogen Fuel Technology' and the other has been conspiring against the development of 'sustainable alternatives' to the 'deadly agrochemicals' for their own vested interest. UNEP report says 3 Republican Senators were seen secretly attending a meeting of Oil Producing Nations in Saudi Arabia. Recently the Prince of Saudi Arabia has realized it and has requested U.S. to give them the technology for development of 'Hydrogen Fuel' in the interest of humanity. In the U.S. farmers practicing 'vermiculture' in agriculture had to face problems with the USEPA. We have also faced problems in India, while educating farmers about use of vermicompost in farming. Agents of agrochemical industries operate in every country misleading the farmers about adverse effects of earthworms on farm soil.

The recent trend of 'deregulation and liberalization' in all countries (even in nations with communist philosophy) have increasingly allowed companies to do much as they like:

1. Their activities generate more than half the greenhouse gases emitted by industrial sectors.
2. They dominate in both mining and trade of natural resources and commodities, thus affecting forests, soils, water and marine ecosystems.
3. They control about four fifths of the land cultivated worldwide for export of crops.
4. They dominate global and national industry and transport, and these developmental activities are major sources of waste and pollution, including toxic and hazardous wastes, unsafe consumer products and occupational health hazards.
6. They are major transmitters of environmentally unsound technologies and production systems and hazardous materials like chemical pesticides (in the name of pest and disease control and crop protection) and hazardous wastes (in the name of recyclables) to the developing countries in the South.
7. They deliberately promote 'unsustainable consumption patterns' in both North and South nations through electronic and print media.

Perhaps the biggest error of the Rio Earth Summit (1992) was its decision not to create a mechanism to regulate the economic activities of 'big companies and corporations'. Although, the NGOs like Greenpeace and the Third World Network who dominated at the Rio Summit had identified the primary role of the transnational corporations (TNCs) in damaging the environment. The economic record of the last decades show that the cause sustainable development loses when governments give up their task of regulating companies. TNCs should also be made liable for economic compensation for the harmful effects of their operation on the environment, safety of workers and ill effects on the health of workers and the residents in the area.

In the U.S., Louisiana's Lower Mississippi River Industrial Corridor has been dubbed by the environmentalists and the local residents as 'Cancer Alley'. It has over 125 companies manufacturing a range of products including fertilizers, paints, plastics and gasoline. These polluting industries were given a 'tax break' of U.S. $ 111 million and the Louisiana government wiped out $ 3.1 billion off the books in property taxes. It was an economic incentive given to the industries to create more jobs even at the cost of human health and the environment. *Ecology was sacrificed at the altar of economy. It was an incentive to pollute more. Sustainability for all' was compromised with 'prosperity for few'* (WB, 2004).

THE POLITICAL PERSPECTIVES FOR SUSTAINABLE DEVELOPMENT

All economic development plans and projects are executed and implemented through some political decision at local, regional or federal level and political decisions are often made to meet the societal goals. In democracy 'eco-vote' plays critical role in planning for development. Sometimes a political decision is taken to fulfill the election promises to a particular section of the society even at the cost of environment. When it comes to setting priorities- whether society is to be benefited or the environment, or both, obviously societal needs come first. The fact remains that if environment suffer, society can never remain apart and is bound to suffer. Political maturity requires a perfect planning for striking a judicious balance between the two.

At the Rio Earth Summit, Brazil, 1992, the whole world

was seen to be divided into two eco-political blocks of North and South on the issues of 'carbon emission' and over the 'rights and access to the genetic resources of the tropical forests'. The 'arrogance and ignorance' of the politicians of some developed nations refused to meet the obligations of Rio Convention and which still continues today. The arrogant statement of the then U.S. President George Bush in 1992, that- "*conventions like these are not going to compel the U.S. citizens to give up their current life-style*" expose the political immaturity of a head of state in planning for sustainable development. Greening of politics is an urgent requirement today and it must be incorporated in the national and international agenda of every nation for appropriate planning and decision making on vital issues of development and environment.

Wrong political decisions made for rapid resource exploitation and economic development in some Asian and African nations e.g. for construction of huge dams for hydro-power, clearing of 'tropical forest' for fodder plantation and export earnings, installation of nuclear power plants and dumping of nuclear and toxic wastes has adversely affected the ecology of the country, irreversibly damaged the ecosystems and biodiversity, displaced and uprooted large sections of human societies from their homes as 'ecological refugees' for narrow socio-political and socio-economic gains. Damages done to the human environment due to the political conflicts and tensions, terrorist activities, wars and battles resulting from international politics unleashed by arrogant political decisions is also of great concern.

Environmental policy decisions would require imposition of some new 'environmental taxes' like pollution tax, waste tax, tree tax and logging tax etc. and reduction in the regular income taxes. It will require to enhance the prices of environmental goods and services (such as water and energy sources) in order to force the society for their judicious use and consumption. Economic incentives have to be given to recycling industries and those saving water and energy in industrial operations by way of reduction in taxation and reduced cost of inputs (raw materials, water and electricity).

Some pragmatic policy decision has to be taken by the government of all nations with regard to water and energy pricing in society and production of consumer goods by the industries. The short-term objectives of reducing the water and power prices may give fillip to high water and energy consumption with severe environmental consequences, waste and pollution. Developed nations are paying high environmental cost (by way of greenhouse gas emission) for the cheap auto fuel, which is in fact at the cost of the whole society. 'Polluter-Pay-Principle' has to be enforced in the matters of water and energy pricing and in the matters of waste generation. There has to be a 'Waste and Pollution Tax' added up with the consumer products, water and the auto fuel at source. Even the government of nations may have to take a hard decision over cutting in the production of 'private cars' and 'subsidize' the cost of public transport instead of the petrol. Government should force the industries to produce and manufacture 'durable' goods and not 'disposable 'ones.

All planning and policies for development of appropriate environmental technologies for sustainable development have to be economically viable and socially acceptable. It is also the responsibility of the academia to educate the politicians and decision makers about the benefits of sustainable development technologies. They have to be educated about the 'hidden cost' of a particular developmental activity and product such as the 'fossil fuels' and 'plastic bags' which is apparently cheap at its face value, but are proving very costly in terms of human sustainability. The convenient but 'non-biodegradable' plastic bags used in the groceries, cause health hazard during manufacture and also recycling. They have to be 'banned' all over the world.

CONCLUSION

It is impossible to separate economic development issues from environmental issues. Almost all forms of development for human welfare erode the environmental resources upon which they must be based, and environmental degradation would necessarily undermine economic development. It is a vicious circle. In the end, the solution to the problem is sustainable development, a process of change in which the exploitation of environmental resources, the direction of economic investments, the orientation of technological innovations and institutional changes are made consistent with the present and well as future needs.

Sustainability in human society with good quality of life for all can be achieved in two ways:

1. By persuading the people to 'behave ethically' towards environment, 'reduce consumption', and have a 'simpler life-style';
2. By embracing the philosophy of 'sustainable development' with appropriate technologies that allow people to enjoy the same good quality of life with high standard of living, but at a significantly lower 'environmental cost' (Schumacher, 1973).

Given the difficulty of changing people, the second option appears to be more pragmatic. However, technology should never be seen as a 'silver bullet' solving all the world's environmental ills. Environmental education for sustainability can definitely change people in course of time and correct human behavior.

Technology has provided environmentally sound alternatives for sustainable development in many cases but there is a sad lack of necessary 'political will' to implement it because there is fear of resistance from the

mighty industrial lobby and their political friends who want to continue with the obsolete and destructive technologies for their own political and economic gains. *Is it not ironic that man stepped on moon in 1969, but has not been able to commercialize the use of solar, wind and* hydrogen power as a viable alternative to destructive oil, and manufacture automobiles run on hydrogen fuels? It is perhaps not favorable to the oil rich nations of world and their 'purchased politicians' in the decision making bodies of west. The 'addiction' to the 'cheap oil' stopped the technologically capable western world to go for sustainable alternative.

In the words of Gerald Durrel (1984), 'At the present rate of progress and unless something is done quickly, disaster stares us in the face. Erosion, desertification and pollution have become our lot. It is a weird form of suicide, for we are bleeding our planet to death. We are led by' sabrerattling politicians' who are ignorant of biology, beset by sectarian groups noted for their narrow-mindness and intolerance, surrounded by powerful commercial interests whose only interest in nature is often to rape it' (Myers, 1994).

There is sufficient evidence to indicate that the world is going on the wrong path of development. It is leading to economic, ecological, social and political deterioration and the worst 'moral degradation' in the name of development. It has given birth to violent societies, violence against both man and nature. There are more accidents, crime, delinquency, drugs, alcoholism and deadly diseases than ever before. Mankind will perish if the protection of the environment does not become an integral part of all technological development, planning and management. We must seek lessons from history. The flourishing civilizations of the past perished not at the hands of any cruel enemy, but due to human's own activity, clearing of forest, overuse of soil and lack of awareness for development compatible with the environment (Meadows et al., 1992).

Making economic development programs less dependent upon the 'fossil fuels' and more dependent on renewable energy sources, less energy and material intensive and more equitable in its social and economic impact on global level is the need of the hour. A 'sustainable hydrogen fuel economy' in place of 'fossil fuel economy' must be established if an environmentally and economically sustainable world is to be left to our children and grandchildren.

A sustainable future for the human society will be determined:

1. Not by the megawatt of energy which will be produced, but by the fact that how they will be produced and from what source?
2. Not by the quantity of food that will be produced, but by the quality of the food, and that how they will be produced?
3. By how soon we get rid of those developmental materials and technologies whose production, application and utilization entails heavy environmental damage from beginning to end of the cycle;
4. By how soon we are able to 'reduce' and 'recycle' all those 'human wastes' successfully and develop safe and benign alternatives to those thousands of 'toxic chemicals' used in various developmental activities;
5. By how soon we are able to commercialize the 'hydrogen fuel technology' for our automobiles and all other renewable sources of energy for power generation;
6. By how soon we switch over completely to 'Organic Farming' to produce 'chemical-free and health protective organic foods' for civilization;
7. By how soon we are able to arrest the dangerously growing menace of soil and biodiversity erosion, desertification and land degradation;
8. By how soon we are able to arrest the exploding 'human population' (consumers on Earth) and the 'culture of consumerism' and learn to live a 'sustainable life-style' by embracing the philosophy of 5 P's (judicious use of paper, petrol, power, potable water and plastics) and 5 r's (refuse, reduce, reuse, recycle and responsibility about waste) in daily life (Seymour and Girardet, 1987; Milbrath, 1989).

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