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HEALTHY OCEANS

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[**Apologia** : I am grateful to the organizers for the honour of delivering the First Foundation Day oration of the Kolkata Port Trust in connection with its 134th Anniversary and the diamond Jubilee Celebration of Rabindra Setu to-day.

With the present condition of my voice, for which I seek your patience, I do not generally accept now-a-days such invitations, but here, meeting Dr. Anup Chanda and other galaxy of personalities lured me to accept the offer. However, the choice of topic was a problem since the only knowledge I have about ports was that it connects various countries via seas and oceans and my present love as an academician is environment and ecology with special reference to climate change. Indeed, we don't know how much the earth's eco-system depends on the oceans and seas, and in general these are used for dumping variety of wastes including hazardous materials. With that in mind, I thought, why not deliberate on Oceans and its role in the maintenance of earth's ecology and the problems arising due to the wanton use of fossil fuels ? Thus I am before you with the topic : 'Healthy Oceans'.]

1. INTRODUCTION : The humankind has entered the twenty-first century facing two major crises – both human-induced : the climatic fluctuation and the water. Whereas the former is basically due to the wanton use of

fossil fuel in energy generation, the cause of water crisis is burgeoning population and unwise food habits.

We live in a bio-sphere consisting of land, ocean and atmosphere-land with hills and mountains- some with glaciers at the top, rivers, marshes and ponds, plain land, deserts and ice-sheets (at the Arctic), and huge forest cover- the habitat of all animals- vertebrates and invertebrates including humans, mammals, birds, reptiles and numerous species, trees, shrubs and flowers etc; oceans- with rocks, hills, weeds, shrubs etc exactly as on the land, all laid out beautifully in a sustainable evolutionary system in which the Sun plays the vital role. And in this bio-sphere, all the species- millions of them, some yet unknown to humans, live in a harmony, yet keeping up its own identity, in accordance with the natural chains and cycles, such as nitrogen-cycle, carbon-cycle, food-chain, etc. They have the capacity of adjustment with the changing situation in its own evolutionary way.

But problem arises when a situation is forced on the bio-sphere in a rapid pace, destabilizing the natural process of regeneration, recovery and sustainable development and that is exactly what has happened and is happening, specially since the middle of the twentieth century, due to human-induced activities, leading to the major crises as stated above. In general, humankind tilled the land, domesticated some animals and birds, constructed roads and bridges, installed factories and cities, built dams and power stations in search of more and more comfort and luxury, but looked down upon the seas and oceans merely as water-ways for movement from one land to another and for some marine fishes as food. Often seas have been used for dumping garbage, nuclear wastes and oil-spills much to the detriment of the various living species under the sea, ignoring the role of oceans in sustainable climate management and

sustainable food security. Indeed, most people think of oceans as so immense and bountiful that it's difficult to imagine any significant adverse impact on it from human activity.

Throughout most of human history, humans lived on the earth's sustainable yield--the interest from its natural endowment. But now, specially from the middle of the twentieth century, greed for quicker and quicker 'development' and prosperity overcame the sensuality and humankind saw itself consuming the endowment itself.

2. ENERGY & OCEANS: History of human development is the history of harnessing Energy. Some anthropologists like to measure the degree of civilisation in any particular period or epoch by the amount of energy consumed by humankind.

But it is absolutely necessary that the production and growth of energy should be compatible with the natural process of sustainability i.e. without wrecking the delicate balance that sustains life of any form on our planet. The total primary energy generation as on end-2002 is 433.81 trillion joules which is 10 times that on 1950, and what is more important is that the humans of the 20th century used 10 times more energy than their forebears during the entire 1000 years before 1900. Moreover, 85% of the present primary energy generation is due to the burning of fossil fuel [Table 1] which has led to the extra deposition of carbon di-oxide in the atmosphere which, in turn, resulted in the global warming. With continuous deforestation all over the world due to urbanization and use of firewood as fuel, the carbon-cycle is disturbed, and between 1958 and 2004 the CO₂- level has climbed from about 315 parts per million (ppm) to 375 ppm.

Oceans are important sinks for absorption of CO₂ and take about a third of human generated CO₂. It has been found that the CO₂ levels at the ocean-surface are rising at about the same rate as at the atmosphere. It has also been observed that in the ocean between 250 and 450 meters deep, CO₂ levels are rising at nearly twice the rate as in the surface water.

This unprecedented flow of energy specially during the later half of the twentieth century has led to a disturbed compatibility touching every living species on the earth in all fronts of their activities, viz. what they eat and drink, how they behave and how they embrace the material-intensive pollution-driven life style. Also, this increased flow of energy in the human society can be correlated with greater coercion and subjugation of people and with increased environmental and ecological degradation.

Table 1

Total Primary Energy Generation as on End-2002 : 433.81 **trillion Joules** .

Fuel-mix : 1. Fossil Fuel ...85 %

[Oil ... 40 %; Nat. Gas... 23 %; Coal ... 22%]

2. Hydro ... 7 %

3. Nuclear ... 7 %

4. Renewables... 1 %

[Mainly- Wind, Solar, Geothermal, & Waste sources]

- IT IS TO BE NOTED THAT INSPITE OF SUCH DEVELOPMENT NEARLY 2.5 BILLION OF PEOPLE TODAY RELY ON WOOD, ANIMAL MANURE AND CROP-RESIDUE FOR THEIR FUEL.

3. GLOBAL WARMING & OCEANS:

Another characteristic of the oceans is that its waters are always on the move- in a complex pattern, Earth's rotation, the prevailing wind, the water's salinity and heat content, and the bottom topography being the prime causes. And as they move, they influence the climatic and living conditions for plants and animals, even on land. Side-by-side, cold and nutrient-rich water is brought up from the depths to the surface which is then pushed away from some western coasts, so that water rises along the western edges of continent to replace it. Marine life thrives in this nutrient-rich water.

Under normal conditions, with tropical heating and cooler northern and southern hemispheres, warm tropical water moves towards the north pole in surface currents. Along the way, it loses heat to the air, its salinity increases, making the surface water denser. The dense water falls deep into the oceans inviting warm surface currents to replace it, thereby making the lower cold and dense water to flow into the South Atlantic, Indian ocean and then to Pacific eventually rising back to the surface and mixing with tropical ocean water. A global "conveyor belt" is set in motion and the 'thermohaline circulation' is complete.

The purpose of such circulation is to maintain sustainable temperatures on every parts of the earth- warming the northern hemisphere countries and cooling the tropical countries.

However with so much carbon di-oxide released into the atmosphere, the global average temperature is on the rise due to the 'greenhouse effect'. There is also a definite evidence of big climate fluctuations all over the world which cannot be accounted for by the natural forces. With the Arctic warming several times faster than most of

the planet due to the 'albedo feedback ' glaciers are melting on the mountain top and ice-sheets at the Arctic.

With Arctic ice melting, the release of fresh water into the oceans may change the circulation of water in the oceans. Recently deep ocean warming has been reported in the Atlantic, Pacific and Indian oceans not only in the sub-tropical regions, but also near the poles.

According to some scientists, this may change the world's basic hydrologic cycle by increasing both evaporation and precipitation. Rainfall in certain places will be heavier, temperate regions will get more floods (since 1900, floods in the US have increase by 20%), disease-carrying insects such as malarial mosquitoes will become widespread. The change in rainfall pattern will affect the fresh water on which we all depend.

Others disagree. But while the debate goes on global warming and climate fluctuation continues.

4. THE RENEWABLE ENERGY OPTION.

The issue is : should we wait and watch or act now. That the issue is a burning one has been admitted by the UN and various Governments all over the world in the UN conference held at Kyoto, Japan in 1997 in which the first legally-binding global agreement to reduce the amount of greenhouse gases emitted by the developed nations by 5.2 per cent of 1990-level during 2008-2012 was agreed upon. The protocol became binding with the Russian Government ratifying the same in October, 2004.

The alternative 'clean' sources of generation and storage of energy has already been demonstrated by the scientists. Solar, thermal, photo-voltaic and also geothermal sources are already well-known, but cost reduction is demanded by the market economy. It is curious that even today, while evaluating renewables vis-à-vis fossil-fuels, environmental

cost is in general not taken into account which, I suppose, is due to 'mental blockade'.

The good news in the late twentieth century is the cost reduction of wind-energy generation and development of hydrogen fuel-cells. Because of improved material and construction technologies, and improved design, it is now possible to achieve a 'capability-factor' of around 40 % through lighter turbine and taller mast, extended range of variable speed and much higher efficiency. It is expected that during the first-half of this century, with wind turbine of MW-rating more than 5 and still taller mast, the generation cost will come down to 1.5 cents (US) from the present 2.9 cents.

But humans have no control over the timings of the blowing of wind and a good method of storage of energy is required. Hydrogen foots the bill. It is curious to know that the great geneticist of the 20th century, J. B. S. Haldane predicted the hydrogen-wind synergy for energy generation in the year 1923 (when he was in his twenties) when he presented a paper at Cambridge University, U.K. He visualized rows of 'windmills' and the surplus energy used for the electrolytic decomposition of water into hydrogen and oxygen. His vision was "so revolutionary at the time that it was met with incredulity by his peers in the Academy".

It is interesting to note that prior to Haldane's prediction, in 1874, water as a new source of energy was visualized by the popular fiction writer, Jules Verne in his book *The Mysterious Island* while describing the adventures of five Northerners during the American Civil War. They were thrown off the balloon while escaping a Confederation encampment and landed in a small island. One day a member of the party, Pencroft asked his compatriot Cyrus Harding, an engineer, what might happen to America's commerce and industry if it were to run out of coal. "*And what will they burn instead of coal ?*" – he asked. Prompt came the reply–

“Water”. “Water decomposed into its primitive elements and decomposed doubtless, by electricity, which will then have become a powerful and manageable force……… hydrogen and oxygen which constitute it, used singly or together, will furnish an inexhaustible source of heat and light, of an intensity of which coal is not capable……… . Water will be the coal of the future.”

We have already moved in that direction. Considerable advancement in Fuel cells has been and is being achieved and we expect major breakthrough anytime. World’s first hydrogen refueling station for cars, buses and trucks has been opened at Reykjavik, Iceland in April, 2003.

May be someday when wind energy generation will be very cheap say, 50 US-Cents, humankind will be able to desalinize ocean water (technology exists but due to cost constraint the use is restricted to riches, such as, at Arabian countries) and solve the looming water crisis.

5. CONCLUSION: For the well-beings of the humans, a sustainable marine eco-system is a must. Apart from what has been discussed above, we cannot achieve lasting and sustainable development without healthy oceans and coasts. No doubt that the global economy has expanded seven-fold, since 1950, raising the output from \$6 trillion of goods and services to \$ 43 trillion in 2000, boosting living standards for a section of population to levels not dreamed before. But such economic output is based in part on cutting trees faster than they grow, overgrazing rangelands and converting them into desert, over-pumping aquifers, and draining rivers dry leading to a water crisis which will lead to food-crisis. On much of our cropland, soil erosion exceeds new soil formation--slowly depriving the land of its inherent fertility. With the help of technology, humans are hauling more fish than the oceans can replace, so fish

population such as bluefin tuna, groupers, and cod are plummeting. As catches decline by about one per cent annually, we are 'spending the principal' of our marine resources rather than living off the interest.

"Not only do we need to stabilize population, raise water productivity, and stabilize climate, but we need to do it at a wartime peed. The key to quickly shifting from a carbon-based energy economy to a hydrogen-based one is to incorporate the costs of climate change, including crop-damaging temperatures, more destructive storms, and rising sea level, in the prices of fossil fuels. We need to get the market to tell the ecological truth."

"We can stay with business as usual and be the generation that presides over a global bubble economy that keeps expanding until it bursts, or we can be the generation that stabilizes population, eradicates poverty, and stabilizes climate. Historians will record the choice, but it is ours to make."

Bibliography

Eco-Economy by Lester R. Brown, Orient Longman Private Limited, Hyderabad, India, 2003.

Vital Signs, 2004 : A Publication of Worldwatch Institute, W. W. Norton & Co. New York, London.

The Hydrogen Economy by Jeremy Rifkin, Penguin Putnam Inc., New York, 2002.

National Geographic : Global Warming, September, 2004.
