

## **CHANGING WORLD AND IMPLICATIONS FOR BENGAL**

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### PREAMBLE

It is a pleasure to be associated with the 136<sup>th</sup> anniversary of an organization with such a glorious past, the only major riverine port in India, and a future that will have to depend on many factors, some of which, like global change, can be indirect but crucial. Since I have no knowledge about ports and port operations, I accepted the invitation to deliver the Third Port Trust Anniversary Lecture with some hesitation after I was assured that I have an open choice on the theme of my talk.

After I accepted the invitation, I read with interest the history of Calcutta Port Trust from the forewords of its Chairman Dr.A.K Chanda and the addresses by Professor Satyesh Chakravarty and of Professor Barun De. What struck me as particularly significant is that the history of the Hooghly river port complex provides an excellent mirror of how Kolkata and the surrounding region grew, including the metropolis. The emergence of science and education in Bengal, with the establishment of Calcutta University 150 years ago, of Shibpur Engineering College completing 150 years shortly, of Jadavpur University 100 years ago and of the Indian Association for the Cultivation of Science some 135 years ago, occurred at about the same time as the setting up of the Port commission. Did these institutions interact with each other and to what effect? It would be interesting to know. For Kolkata was a cradle of scientific and academic knowledge for over 100 years and the renaissance of Bengal in the early twentieth century with Raman-Saha-Bose- Ramakrishna- Vivekananda- Tagore – Gandhi – Nehru is still an

epoch that we are trying to understand. The miracle decade in the 20's when science and technology suddenly flowered needs to be connected with other developments in the region. In this context, it will be of interest to note the comments made by Nobel Laureate Professor Chandrasekhar.

#### CHANDRASEKHAR'S COMMENTS

“It is a remarkable thing that in the modern era before 1910, there were no Indian Scientists of international reputation or standing. Between 1920 and 1925 we had suddenly five or six internationally well known men. I have myself associated this remarkable phenomenon, with the need for self expression which became a dominant motive among the young during the national movement”.

In the days when we were students, Kolkata was blazing with scientific giants. In our M.Sc. classes in Physics, we had teachers like Satyendra Nath Bose, Meghnad Saha and Sisir Kumar Mitra, three Fellows of Royal Society, which is now unthinkable in Calcutta or anywhere else in India. This excellence however declined gradually. Good students and teachers moved to other parts of the country – to Delhi, Mumbai, Bangalore; to other universities and to the many scientific institutions that began to come up. There were new attractions from Atomic Energy Commission, from the Council of Scientific and Industrial Research, from the agricultural institutions and later from Indian Space Research Organization and Defence Research Establishments. Students from Bengal excelled in these places but left institutions in Calcutta weak. Students are attracted to places where they find learning exciting. They remember such teachers all their life.

## BENGAL IN RECENT YEARS

There is, however, now a reverse swing. In the last few years, Kolkata has blossomed. I have seen remarkable resurgence of some of the Institutions: University of Calcutta, Jadavpur and the newly established WB University of Technology. Shibpore Engineering College, is now a university. Indian Association For Cultivation of Science, Bose Institute, S.N Bose Centre for Theoretical Physics, Saha Institute of Nuclear Physics, the two CSIR Research Laboratories, Indian Institute Of Chemical Biology and Central Glass & Ceramic Research Institute, the Variable Energy Cyclotron Centre are all world class institutions led by very distinguished people. With the abundant talent available, some untapped and some inadequately tapped, all that we need for Kolkata to lead is a consortium approach – an approach to network, share resources not only of facilities but also human expertise - an appetite for daringness for no innovation is possible without daring, and an integration with science, technology and society.

This region is also changing in other ways. Some of these are not positive. The habits of conspicuous consumption, so common in western countries and increasingly seen in other parts of India were muted in Bengal. Whether this was due to lack of wealth or a result of culture and attitude is hard to decide. This consumption mania has, however, caught up with Calcutta in recent years with disastrous consequences.

There are other negative aspects. Communication revolution bringing in conceptual changes in attitude, in value systems, in plans for economic development has brought in an unfair competition with Tagore's concept of education for personal development. The concept of success is moving towards the concept of personal wealth.

Human development, now defined in physical terms, misses parameters like social tolerance, family values, compassion, contentment, peace, a thirst for something that makes life worth living.

Education itself will thus need a reorientation.

### THE CHANGING WORLD

The changing scenario for the Kolkata and the surrounding regions, I have outlined, is common to all developing world, and increasingly also to developed world.

The first lesson is that regions change and with them, the whole world. There are different aspects of these changes: technological, political, social and state and nature of civilization. The key technological change is on connectivity – the “flat earth” concept and the “knowledge” world. It goes beyond technology. Countries like India, China, Brazil with scientific strengths on ICT, modern biology and materials are now on equal terms with the USA and Europe.

Political changes will, however, go along these “knowledge” scenarios with their own agenda, for even with global connectivity, self interest will dictate the clash of civilizations.

A new paradigm will be the role of religion in society and government. An emerging question is of the sanctity of nature (fallacy of savagery to civilization), the question of ethics in new scientific innovations and what science can learn from culture and vice-versa. Science, for example, provides a great unifying force, since it is the same elsewhere. Culture has a long memory, slow in changing, but provides a clue to what is important and what is not.

The second lesson is: shift in the regions of excellence and problem areas, instead of decreasing, go on increasing both in number and extent. Areas of excellence shifted in the past from Asia to Europe and then to the USA, and are now shifting back to Asia. In a smaller scale, excellence in science, technology and culture is shifting from one part of India to another.

Change is thus an integral part of the world. This is how life has evolved – oxygen, initially absent in the earth's atmosphere, emerged from life as it emerged, and with it came the blanketing ozone layer, allowing life from the sea to move to the land. For nearly half a million years for which experimental data are available from ice cores, the atmospheric temperature has oscillated from high to low – alternately producing ice ages. But the changes have been within a set of boundaries and it seems as if the earth has been controlled by a huge thermostat!

The last 20,000 years has, however, been different. We now see a new kind of change. After the last ice age as the early humans moved from one region to another, and began to form communities, agriculture emerged catalysing growth, cementing communities, producing new cultures but also disturbing the ecosystems. The present day world owes its wealth and well-being to human ingenuities catalysing industrial revolution, but the three main inventions - the steam engine, the Haber Bosch process for ammonia production and the Chloro Fluro Carbons (CFCs), the wonder molecules for refrigeration - now, in retrospect, have been the most disastrous for humanity. The beginning of what we now call the anthropogenic era, the era when human activities are beginning to endanger the earth system. The first started burning fossil fuel emitting Green House Gases (GHGs) and pushing population tenfold, the second by catalyzing

agriculture explosion produced eutrophication of surface and ground water, produced the climate changing gas  $N_2O$ , the third nearly destroyed the ozone layer.

Thus we are having two kinds of changes - gradual and drastic. The drastic changes are now taking over the gradual ones. There have been catastrophes in the past destroying civilizations. The demise of Indus Valley civilization is one example.

There is a third kind of change –a gradual one but monotonically shifting the base level. The kind of change we now see in the world as a result of human innovations: evolutions in communication, genetics and materials. The level is that of shrinking distances, of breaking barriers between sciences and between sciences and humanities. We are beginning to understand the basis of life, will perhaps connect with extraterrestrial intelligence soon, will produce sensors thinner than human hair. The scene is changing so rapidly that it is impossible to predict what the next century will look like.

Can human society change equally fast? Society changes more slowly, has regional and community prejudices that cannot be shed off so easily and is region, community and religion – dependent. At the same time, its long memory has advantages, carries value concept to future, and encourages diversity. While the earth is getting physically smaller, humanity is not getting unified. Separate ethnic groups, dissimilar and sometimes hostile, are proliferating. We are creating hotspots, randomly scattered over the earth, changing with time only in the nature and distribution of these problem spots. We thus have the curious state of modern civilization; one Earth but many societies.

## THE FUTURE WORLD

The focus will shift from geographical control to resource control. We have now a world fighting for control of oil. Energy security is a dominant control factor. We visualize a gradual shift from energy control to the control of water resources. For, this is going to be one of the most scarce and variable resources, once climate change impacts begin to dominate. Wars will be fought for water, as it is now for oil.

Superposed on all these will be the problems for Global Change. For this century, this is the overarching issue cutting through all human activities – technological, social, political and human.

Here we are no longer talking about millennia, but of decades – of runaway changes in the earth system moving it to a phase that we call non-analogous. The earth system is in a metastable stage – any change to another state can introduce profound changes in the system.

We are witnessing already events of intense storms and floods, unseasonal weather; landslides and avalanches, dying forests and desertification, melting icecaps and rising sea level. In intensity and magnitude, some are quite unexpected. The Katrina hurricane disaster or the Bombay floods, days of intense heat that are abruptly descending on different parts of the world, the deteriorating coral reefs, drastic extinction of species are examples of the hazards yet to come. We seem to have moved out of the usual range of variabilities of atmospheric parameters and random drastic perturbations are occurring and occurring in different parts of the world. Stephen Hawking is fantasizing about accelerating chain reactions that may in future catalyse migrations from the earth.

We are thus entering a new world – human induced – with no analogue in the past with changes that cut through physical, social, developmental and political levels. In short, the entire human development process.

On the physical side, we have seen new actors in climate forcing system. The old actors are the long-lived greenhouse gases. The new actors come from air pollution – ozone, carbon monoxide, nitrogen oxides and other suspended particulates. Energy production is the major culprit i.e. the driver for economic development is itself a villain. If the production process is inefficient – as in India and many other developing countries, we also produce air pollutants that we now find are also climate forcing in regional and even global scales. A third problem is the so-called “brown cloud” – presence of a huge canopy of black carbon, result of inefficient combustion of coal and oil and also of biomass burning. Rural cooking systems using fuel wood, cow dung cakes, kerosene, charcoal are major contributors.

What about human society? It is in a lose-lose situation. We have exhausted, in a few generations, fossil fuel generated over several million years; 50% of mangroves have been removed, wetlands have shrunk by half; over 20% of recognized fisheries are already depleted; 50% of land surfaces have been transformed. For us, solution is not easy. Energy is in short supply in India, inefficiently produced and coal-centric (as in China). Non-conventional energy system is still on the national fringe, although in solar energy development, India is a pioneer. Solar thermal systems were developed in the National Physical Laboratory nearly half a century ago. Wind energy development is excellent; solar PV system is at an advanced stage; bio diesels are in upswing; biogas systems are being encouraged. But these take time. Meanwhile biomass burning is



producing life threatening pollutants of a magnitude that is politically explosive. The standard comment that “this is survival emission” is ironical for an emission that is life threatening.

Here we encounter complex reactions from both political and social systems. The big emitters of the classical GHGs are the developed countries. With 4% of world population, USA contributes 25% of the entire global emission. Per capita emission of India is only 1/25<sup>th</sup> of USA and Indian’s insistence on per capita parity clashes with western priorities on development. The USA insists on China, India and Brazil also to come under emission control strategy. There is not enough space for both groups to go on as usual, for then we shall soon cross the concentration thresholds beyond which the threat becomes really serious and perhaps even irreversible. The question is then how does one balance between development and environmental threat? There are other factors in this game of political upmanship. Realising that air pollutants are principally a developing country product - the brown cloud is particularly dominant over developing Asia, over Africa and over the Amazons in Brazil - political mudslinging is raging. Europe and USA and, increasingly, Japan are concerned with invasion into their atmosphere of huge brown and yellow clouds through long distance transport. We are also entering into new regimes of law about environment jurisdiction.

The most precious commodity in this changing world is a stable climate. This in the changing world is a resource. The question of equity is raised. Every citizen should in the long run have an equal emission quota. A new approach is the concept of Contraction and Convergence. It is a policy that to us seems reasonable. It urges that global

emissions be cut from the present global average of 1tc/cap to 1/3 of this value, equally shared, by 2040.

The problem is not only that of climate. Connected with it is the question of how we view nature. The western concept of “taming nature”, quite different from the Indian concept of “living with it” has changed the earth system – its waters, its air, its ecosystem, its life forms and, in the process, the interacting processes between the different components. The Indo-Gangetic Plains, the food basket of India, and with the Himalayas, the source of perennial water, has been drastically altered: several glacial lakes are on the point of bursting and the Himalayan glaciers are melting at a rate faster than elsewhere, being located in tropical zone, the Himalayan river systems draining into the Ganga basin are gradually “dying out”; the sediment flow is alarming; water discharges in the Ganga- Brahmaputra- Meghna system has shown a sharp decrease in recent time. India is one of the 12 mega diversity countries commanding 7% of world’s biodiversities and supporting 16 major forest types ranging from the alpine pastures in the Himalayas to temperate, subtropical and tropical forests and mangroves. This resource is fast depleting. We have a coastline of over 7500 km, populated by over 10 M people in nine coastal states and a high population density over 450 persons/km<sup>2</sup>. India’s long coastline and the extensive exclusive economic zone is a major resource undergoing rapid degradation.

### IMPLICATIONS FOR BENGAL

The future world is thus one of drastic changes, but is also a knowledge-driven world, a world of increasing hotspots of ethnic intolerance, of complex issues of ethics and morality, of conflict and convergence of science and society, of clash of civilizations and

a tussle for countries trying to dominate resources of energy and water. It will also be a world where the question of environment as a resource will increasingly dominate national ethos.

In this changing scenario, can India play a major role? And in the Indian role can Bengal may again be an important player? There are two opposing aspects. One aspect refers to how we meet the consequences of the changes. For example, how will Bengal deal with the damaging changes in the Sundarbans and the increasing intensity of severe weather events? A different role is that of a catalyser of changes. The key issue will be how we develop our knowledge society. President Kalam has identified two important components of such a society: societal transformation and wealth generation. Societal transformation is on education, health care, agriculture. Wealth generation will come from competence in key areas.

Let us first talk about our competence in handling the consequences. One key region is the Himalayas and Indo-Gangetic plains and especially the Ganga-Brahmaputra-Meghna delta. These include heavy sediment flow, fast decreasing level of water discharge, and increasing occurrences of climate disasters, such as floods, cyclones and heavy rains. Intensity of extreme climatic events is now exceeding the normal range of variability and this will have special consequence on the Sunderbans, riverine ports, fishermen, abrupt changes in direction of rivers, land fertility and landslides in the fragile mountainous systems like Darjeeling. Storm surges will increase and rise in sea level will change the coastal regions. For future planning of riverine and seaports in this region, such changes in sea level, in sea surface temperature, in coastal erosion, in ocean circulation and intensity and occurrences of storm surges will need to be addressed. This

will require a consortium approach – of several institutions and several groups working together. The Port Trust Authorities can consider possibility of a Joint Research Programme – I emphasise the word joint – to assess, model, find solutions for those aspects that are of significance for its function.

Let us look at the new knowledge world and how it will affect Bengal. There is reason to hope that Bengal will be one of the leaders with its cluster of excellent centres, and abundant talent and its heritage of Tagore and Vidyasagar, and the Bengal Renaissance of early 20<sup>th</sup> Century. The strength is the existence of multi area excellence. Radio science was pioneered by J.C.Bose and S.K. Mitra many years ago; nuclear science and technology by Meghnad Saha, statistics by Mahalanobis. It is not difficult to visualise a major role from Bengal in ICT, genetics, materials, new energy, intelligent computing. Such excellences also exist elsewhere and currently at a better level in some places. To be effective we will need to understand several key issues. One is that “knowledge” is not limited to physical and biological sciences only. One has to add to this, societal knowledge. The physical and social science will have to merge, as we did during Bengal Renaissance. This will require a change in the mindset and also in educational system. Social Science should be part of the syllabus for science students and science for humanities students. The second is that the knowledge will have to be applied to major problems of society. Society has to be a beneficiary. But it can also be a contributor. If, for example, we wish to introduce eco-tourism in the Sunderbans, we need to simulate effects of any new steps introduced. The present controversy as distribution of land for agriculture and industry can be addressed through model simulations of different options. The effect of climate change on the future of Kolkata

Port can be simulated. This brings up the question regarding development of mathematics and of modeling. India's early reputation on excellence in mathematics has to be revived. For Kolkata Port Trust, a viable modeling group can be useful.

The third is integration with arts, literature, philosophy, drawing upon the strengths already existing. To what extent this is possible is difficult to conjecture, but we still have centuries of Indian philosophy, rich and varied music, writers of excellence, and the rich dance forms in different parts of the country. Bengal can have special advantage.

The most important, however, will be to recognize the value of excellence – acceptance of elitism – the need to raise the level and not to lower it (to satisfy populism) i.e., to create “brand names”. Political and administrative systems will have to recognize that creation of excellence requires non-interference and respect for excellence. I see very often political and bureaucratic actions that destabilize excellence when it has taken years to create it. Our heroes will have to come from knowledge giants and not only from those who are rich and powerful.

History has not been made in a day. This is true even more for human knowledge. We are beginning to realize the importance of past knowledge on which the present is built and the future will lean on. It is more than digitalizing traditional knowledge: it is a cumulative knowledge building. In science we use a phrase “back to the future”. This is usually referred to states of past worlds – the air, the sea, the ecosystem and climate. Now we should begin to think also of past attitudes, evolution of consumption patterns, changing philosophies and concepts of ethos. For Bengal, the past is not long, but very rich.

The new Bengal would have to be rich not merely in science and technology but also in the traditions left behind by Vivekananda, Ramakrishna, Vidyasagar, Tagore, Nazrul; in the culture that created goddess Saraswati to show the importance that we attach to learning.

In this, the first step will be to trace back to periods 150 years or more, and examine the progress of science, technology and operational services in this region to the present times, understand why the decline started at certain times, and when and why we peaked in excellence. I had suggested Calcutta University to put on its websites major events of excellence in its 150 years; I will make the same suggestion to Kolkata Port Trust.

Finally, people. People create progress. People with passion will create history. We are short of experts in the age group 35-45. Daring concepts come from youth. One way of enriching us is to bring in young Indian experts in the USA and Europe as external faculty and partners. I have introduced this in IACS and hope to persuade other organizations to do so. Taiwan and Korea have done so with remarkable success.

Ladies and Gentlemen, let me end by wishing Kolkata Port Trust a glorious future.

Thank you.