Water, land and India's economic expectations

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In an atmosphere of globalization of trade, India is expecting strong economic growth at a steady rate over the foreseeable future. Although such an expectation may be reasonable from a perspective of commerce, an examination of India's water and land resources suggests that the potential for even a modest rate of steady growth over the next several decades will be severely limited by the finite capacity of the water resource systems, and the vulnerability of the environment and ecosystems to unacceptable degradation.

Six decades after independence, India is looking ahead to a promising economic future. Aided by unprecedented influx of foreign capital over the past decade, India has been experiencing impressive economic growth, with a reported[1] rate of 9.4% for 2006–07. Even if one were to assume a modest annual growth rate of 6%, India's economy must double in real value every dozen years. Thus, the expectation is that India's GDP should grow from about one trillion US dollars in 2007 to about 4 trillion US dollars by 2031, and 16 trillion US dollars by 2055.

These expectations involve very large numbers, and their significance is hard to comprehend. Yet, they profoundly affect the life of the common citizen. If so, are there ways to look at these economic forecasts, other than those of commerce and trade? Perhaps there is. One way is to consider economic growth from a perspective that shifts focus from commerce and trade to water and land. The rationale for this is that society has to ultimately depend for its sustenance on natural resources such as water, land, minerals and fuel that are derived from the earth. As these resources are extracted, they become depleted, some permanently, and others at rates faster than what nature can replenish. In addition to depletion, the very act of extraction of natural resources impacts the human and biological habitat, often deleteriously. Reduction in freshwater resources, salinization of soils, encroachment of deserts, loss of ecological habitats and endangerment of species are some examples of deleterious impacts. Therefore, it is pertinent to inquire what the prospects for India's economic growth are, given that continued economic growth implies a continued increase in the rates at which the earth's natural resources are extracted.

India's economic growth entails two major consequences. One is the expectation of enhanced standard of living among all segments of society, and the other is the production of more goods and commodities to satisfy expanding needs of trade. Both these consequences contribute inevitably to increased stresses on an already stressed earth and its water resources. If so, one has to examine the extent to which India's natural resources systems are currently utilized, and the extent to which they could withstand continued stressing at accelerated rates to facilitate a real doubling of India's economy every dozen years.

In a technological world, India's economy depends on a variety of earth resources, including fossil fuels, radioactive minerals, metalliferous ore deposits, water, forests, soils, and building materials. For purposes of gaining insights, we may limit consideration to water and the landscape. India has an average annual rainfall[2] of about 1170 mm, spread over an area of 3.28 million km^2. This translates to an annual input of about 3840 km^3 of water as rainfall. Of this, a significant portion goes back to the atmosphere as evaporation by sun's heat, and as transpiration by plants, collectively referred to as evapotranspiration. World-wide experience in the field of hydrology indicates that annual evapotranspiration over the continents varies on an average between 60 and 80% or more of the total rainfall. For India, an estimate of 69.5% has been suggested[3]. Even the lower value of 60% would suggest that 2300 km^3 of India's annual rainfall is consumed as evapotranspiration, and is unavailable for human use. The remaining 1540 km^3 constitutes surface run-off in rivers and streams and infiltration into the soil zone and the groundwater reservoir below the water table. Water required for human use (agricultural, industrial, municipal, and domestic) must be derived by diversion from surface run-off and groundwater infiltration. However, plant and animal communities distributed throughout the land depend for their sustenance on the same surface-water run-off and groundwater infiltration. Thus, diversion of water for human use has to be moderated so that plant and animal communities are not unduly deprived of their sustenance because of reduced water availability. For this reason, and for reasons of technological complexities associated with manipulating earth systems, there are definite limits to the portion of the 1540 km^3 that can be diverted for human use. Here again, experience in different parts of the world suggests that perhaps 40–50% of this quantity, or 620–770 km^3 of water may be amenable to extraction for human use. Available estimates[4,5] suggest that the current rate of water use in India is between 634 and 645 km^3. Together, these estimates indicate that India's current rate of water use is close to its full replenishable potential. In other words, India is currently utilizing its water resources close to its full capacity. If India's economy has to increase fourfold over the next 25 years, then the country's water use has to increase significantly beyond its estimated full capacity.

We must now go beyond water availability for human use and examine the impact of intense economic development on the integrity of the resources themselves. To simplify comprehension, we may restrict attention to potential impacts of disposal of wastes and extraction of construction materials.

Vigorous economic growth, accompanied by industrial development and urbanization will necessarily lead to phenomenal increase in waste of various kinds, both toxic and non-toxic. Information technology, which fuels India's economic growth, is also responsible for generating massive quantities of liquid and solid wastes associated with electronic materials. This type of waste was practically unknown a few decades ago. Although no reliable estimates are available on the

magnitude of domestic and industrial wastes generated in India, it is reasonable to assume that there will be unprecedented increases in their quantities and toxicities throughout the country as economy grows rapidly. There is no way but to dispose these wastes on land, in landfills and other suitable facilities, where they will remain for centuries to come. The hazard associated with landfills is slow, long-term contamination of precious groundwater resources. Selection of sites for safe disposal of wastes has to be based on geological and hydrogeological conditions, as well as acceptance by local communities. For this reason, finding suitable waste-disposal sites is a difficult task.

Continued economic growth also entails continued increase in the construction of roads, bridges, buildings and other civil engineering structures. Construction in turn has to rely heavily on massive production of earth materials such as clay, sand, gravel and limestone. These materials have to come from river and stream beds, and sediments and rock formations. Large-scale quarrying and mining of these earth materials will inevitably contribute to degradation of water sheds, soil erosion, and destruction of fish and wildlife habitats. These environmental and ecological hazards severely limit the extent to which construction materials can be produced at rates that can sustain steady economic growth.

The examples of waste disposal and mining of construction materials provide a glimpse into the complex ways in which water resources management, land use planning, and preservation of ecosystems are intimately interlinked. Since economic liberalization in 1991, India has been experiencing explosive growth in construction associated with industrialization and urbanization. In an effort to keep pace with rapid inflow of capital, construction activities are allowed to proceed at a phenomenal rate, with very little time devoted to examining impacts on water resources, the environment, and ecosystems. There is little evidence to suggest that this state of uncoordinated rapid development will change any time soon.

In essence, India's economic situation in relation to its natural resources is that the country seems to be using its replenishable water resources to full capacity. But, due to lack of coordinated planning and lack of a coherent national water policy, distribution of water resources among various segments of society is far from efficient. Even to improve the current state of inadequacy in water distribution, India faces formidable challenges of policy, administration and social attitudes. At the same time, the quantity of water that nature can provide for human consumption is finite and fixed, and its effective availability is progressively threatened by uncontrolled use, contamination, and destruction of watersheds. Given these facts, one cannot rationally expect that India's water resources will continuously keep pace with the increased demands of a growing economy.

Clearly, India is capitalizing on science and technology for its ambitious economic growth. If so, how may one account for India's lack of attention to the role that earth-science plays in economic growth? One possible explanation may be the confidence that spectacular growths in contemporary science and technology, aided by financial incentives stemming from competition, world markets, and rights to intellectual property will help conquer any obstacles that come in the way of economic growth. But, this reliance on technology must be moderated in dealing with the earth. Although principles of physics and chemistry play a vital role in comprehending the earth; there are aspects of the earth and its biological systems that transcend physics and chemistry. The complexities and interconnections among earth and biological systems place severe limits on the extent to which science and technology can foresee their behaviour or control their functioning to suit human aspirations. Science and technology cannot increase water availability, which is dictated by climate and physiography. Used wisely, science and technology will help use water efficiently and effectively. Expectations of steady economic growth would become even less meaningful if, because of global warming, low-lying areas of high population density get inundated, or if multi-year droughts drastically reduce water input from rainfall.

India's economic health depends vitally on its ability to utilize its water and land resources judiciously and thoughtfully. At present India is in a water crisis, with uncontrolled over-production of groundwater in certain parts of the country, pollution of little protected water bodies, and rapid land development. Pressures to solve economic and political problems in the short-term appear to overwhelm any desire for thinking about the long term. There seems to be an underlying confidence that water and natural resources problems will be overcome by technology and market forces. However, our current state of knowledge of the earth tells us that there are no simple solutions or technological fixes for India's natural resource problems. To assure efficient and equitable distribution of available water even at the present economic levels, India has to pay serious attention to the earth, and formulate policies that, at their core, recognize the attributes of natural resource systems. The fact that economic expectations of steady growth based simply on human desires are pursued at all, is indicative of a mindset that vital national policies can be based entirely on political and economic aspirations, with scant regard to the nature of natural elements that dictate human sustenance.

Despite impressive performance of India in international business, one finds a notable lack of balance in Indian thinking with regard to understanding the earth on which society at large has to sustain, and human values within which science, technology and wealth have to function in a civilized society. Without such balance, the country's economic expectations of continued, steady growth over the coming decades can have no credibility.

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